

AMERICAN COLLEGE OF OCCUPATIONAL AND ENVIRONMENTAL MEDICINE

Knee Disorders

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SUMMARY OF RECOMMENDATIONS

The Evidence-based Practice Knee Disorders Panel's recommendations are based on critically appraised higher-quality research evidence and on expert consensus observing First Principles when higher-quality evidence was unavailable or inconsistent (see Methodology). The reader is cautioned to utilize the more detailed indications, specific appropriate diagnoses, temporal sequencing, preceding testing or conservative treatment, and contraindications that are elaborated in more detail for each test or treatment in the body of this Guideline in using these recommendations in clinical practice or medical management. These recommendations are not simple "yes/no" criteria.

Low-quality randomized controlled studies (RCTs) and other non-randomized studies were reviewed by the Evidence-based Practice Knee Panel to be all inclusive, but were not relied upon for purpose of developing this document's guidance on treatments because they were not of high quality due to one or more errors (e.g., lack of defined methodology, incomplete database searches, selective use of the studies and inadequate or incorrect interpretation of the studies' results, etc.), which may render the conclusions invalid. ACOEM's Methodology requires that only moderate- to high-quality literature be used in making recommendations.

All ACOEM guidelines include analyses of numerous interventions, whether or not FDA-approved. For non-FDA-approved interventions, recommendations are based on the available evidence; however, this is not an endorsement of their use. In addition, many of the medications recommended are utilized off-label. (For example, anti-epileptic agents have been used off-label since the 1960s to treat chronic pain.)

Recommendations are made under the following categories:

- Strongly Recommended, "A" Level
- Moderately Recommended, "B" Level
- Recommended, "C" Level
- Insufficient-Recommended (Consensus-based), "I" Level
- Insufficient-No Recommendation (Consensus-based), "I" Level
- Insufficient-Not Recommended (Consensus-based), "I" Level
- Not Recommended, "C" Level
- Moderately Not Recommended, "B" Level
- Strongly Not Recommended, "A" Level

WORKFLOWS

- Master Algorithm. ACOEM Guidelines for Care of Acute and Subacute Knee Disorders
- Algorithm 1. Initial Evaluation of Knee Disorders
- Algorithm 2. Initial and Follow-up Management of Knee Disorders
- Algorithm 3. Evaluation of Slow-to-Recover Patients with Knee Disorders (Symptoms >4 Weeks)
- Algorithm 4. Surgical Considerations for Patients with Anatomic Evidence of Ligament Tears and Persistent Knee Symptoms
- Algorithm 5. Further Management of Knee Disorders
- Algorithm 6. Management of Ligament Tears and Osteoarthrosis for Patients with Knee Symptoms
- Algorithm 7. Management of Knee Osteonecrosis

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INTRODUCTION

The following knee disorders are covered in detail in this guideline. There are other disorders not reviewed in this guideline in depth that should be considered in the differential diagnosis of knee pain and knee symptoms. These include lumbar radiculopathy, especially L3-4, and lumbar spinal stenosis (see Low Back Disorders guideline), osteochondritis dissecans, vascular disease, avulsion fractures, femoral mononeuritis, tumor, cancer, crystal arthropathies (e.g., gout, pseudogout, hydroxyapatite), and infections, including septic arthritis (see Basic Principles and Definitions for normal anatomy). Several of these disorders have a tenuous relationship with work, but are included for purposes of completeness (see Work-Relatedness Guideline).

Avascular Necrosis

See Osteonecrosis below.

Infra-Patellar and Pre-Patellar Bursitis

Bursitis occurs when the bursae become inflamed and irritated, although classic symptoms and signs of inflammation are not always present. Bursitis results in swelling and pain when muscles overlying the bursae are used. There are many bursae around the knee, and this discussion includes some of those more commonly affected. Infra-patellar bursitis typically involves the bursa between the patellar tendon and the skin, although there also is a deep bursa between the tendon and tibia. Pre-tibial bursitis involves the bursa between the tibial tuberosity below the knee and the overlying dermis. Pre-patellar bursitis involves the bursa between the patella and the overlying dermis. Anserine bursitis (also pes anserine bursitis) involves a deeper bursa located between the conjoined tendons of the sartorius, gracilis, semitendinosus, and the medial collateral ligaments. Treatment of bursitis has most commonly included avoidance of kneeling or other exposures, NSAIDs, glucocorticosteroid injections (with or without aspiration), and rehabilitation therapy.

Fracture of the Knee

Knee fractures include frank fractures and dislocated, hairline, and “stress” fractures. All fractures involve an application of force that is beyond the strength of the bone. In the knee, fractures can occur in the tibia (commonly as the tibial plateau), fibula, or patella. If force is applied that is insufficient to fracture the bone, bone marrow edema may occur from the injury, which can be visualized on MRI exams. Many of these fractures require surgical fixation, but treatment can range from immobilization with a knee brace to casting immobilization to surgical fixation, depending on the severity of the fracture. Stress fractures typically involve repeated applications of unaccustomed force over a relatively short interval of hours to a few days. These are usually treated with elimination of the offending exposure and observation. Fractures may also occur in the setting of osteopenia/osteoporosis. Physical therapy assessment to address movement system impairments, such as muscle performance and motor patterns, may assist in developing management plans to reduce forces on the affected site.

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Groin Strains

See Hip and Groin Disorders guideline.

Hamstring, Calf, and Quadricep Strains, and Tears

A strain usually consists of a disruption of a myotendinous junction. The lower extremity is particularly prone to muscle strains, and strains of certain structures are more common than others. A hamstring strain involves the hamstring muscles of the thigh and can be located either distally or proximally depending on the strained muscle-tendon unit, usually in the long head of the biceps femoris muscle. Calf strains typically involve the gastrocnemius or soleus muscles in the upper calf. Quadricep strains involve one or more of the quadriceps muscles as they insert on the superior patella. Complete muscular tears typically involve the application of an extreme force and usually occur in the same muscles prone to developing strains. Strains are most commonly treated by removal from high force activities, NSAIDs, and therapy for more severe cases. Immobilization is sometimes implemented. Complete tears/ruptures of the quadriceps tendon or patellar ligament commonly require surgical repair while other muscle-tendon units are usually managed non-operatively.

Iliotibial Band Syndrome

This entity is common in runners, cyclists and participants in endurance sports. Pain is in the lateral knee. Treatment is largely empiric, as quality evidence is sparse, and may consist of NSAIDs, exercises in a formal therapy program, glucocorticosteroid injections, and deep friction massage.

Lumbar Radiculopathy and Lumbar Stenosis

These disorders may present as knee, thigh, and calf pain. Thus, they should be considered in the differential diagnosis of knee pain (see Low Back Disorders guideline).

Meniscal Tears

Menisci are prone to degenerative changes and tears become ubiquitous with age. Meniscal tears frequently accompany degenerative joint disease. Younger patients tend to tear with high-force discrete trauma as a result of sporting activities such as football or soccer. Older patients tend to acquire tears over time, without any inciting event or with relatively mild trauma, during performance of usual activities (e.g., stair climbing). The mechanism of symptom onset may help determine whether it is more likely degenerative or traumatic in nature. The medial meniscus is 2.7-fold more likely to be torn than the lateral meniscus [(1)]. Pain tends to be focal – e.g., at the posteromedial joint line for a medial posterior horn meniscal tear. Joint effusions tend to occur if there is an acute, large tear. Small degenerative tears may produce no effusion. Treatment of large “bucket-handle” tears involves surgical removal or surgical repair. Meniscal repair may also be an option for

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younger individuals when there is an acute tear in the vascular zone, although the expediency of surgical repair must be balanced against longer-term increased risks of knee OA. Treatment of degenerative and small tears involves NSAIDs, activity modifications to avoid aggravating activities, glucocorticoid infiltration, and therapeutic exercises. Surgery may be needed in cases where non-operative results are not satisfactory.

Osteoarthrosis including Degenerative Joint Disease ("Osteoarthritis" and "Degenerative Arthritis")

Degenerative joint disease (DJD) of the knee is most commonly caused by osteoarthrosis (OA). While osteoarthritis is the more common name for this entity, osteoarthrosis is more technically precise since there is no classic inflammation. Other types of arthritic disorders that cause DJD include inflammatory autoimmune disorders (e.g., rheumatoid arthritis, systemic lupus erythematosus, and psoriasis), crystal diseases (e.g., gout, pseudogout, apatites), infection or obesity (cytokines). These latter disorders are non-occupational and are not included in this discussion. Knee OA and inflammatory knee arthritis can result in destruction of the knee joint, and these conditions may therefore be indistinguishable on x-ray. Thus, a correct interpretation of an x-ray may include DJD, but not “osteoarthritis” in contrast with widespread practice.

Age, obesity, genetics, and prior trauma are robust risk factors for knee OA (see Risk and Causation). For most joints in the body, there is a modest female preponderance for OA; the knee is no exception, with an estimate of 84% higher risk in women than men for reasons that are unclear [(2)]. Patients who already have OA in one or two joints are at higher risk for developing OA in other joint groups. When there are three or more body regions involved, this is sometimes referred to as “systemic osteoarthrosis.” Systemic osteoarthrosis likely reflects genetic or other systemic predispositions. Several genetic risk factors have been identified, and there are different joint patterns of involvement with knee osteoarthrosis [(3)].

OA is more common with age and is associated with thinning of cartilage on the articular surfaces of the knee joint. Thinning of the cartilage in the knee joint may lead to pain with movement and stiffness. OA is generally characterized by stiffness (and pain) after both long periods of inactivity or in association with unaccustomed increases in activity. Most cases of OA are symmetrical and appear to arise without obvious physical exposure(s). DJD may also occur from a remote associated injury (e.g. previous meniscal or ligament injury) and/or instability. A minority of cases occur after discrete significant trauma, most commonly fractures. The disease tends to progress irrespective of physical exposures.

Osteoarthrosis: Initial Interventions/Role of Rehabilitation Therapy and Other Non-Pharmacologic or Non-Invasive Interventions

Many patients with knee osteoarthrosis are able to control their pain adequately through specific exercises (typically aerobic and quadriceps strengthening), avoidance of activities that significantly provoke symptoms and through the use of over-the-counter (OTC) medication. Topical agents, heat, and ice may be helpful self-treatments. Braces, neoprene knee sleeves and orthotics/insoles are sometimes helpful. Patients may benefit from education about the natural history of knee OA. Regular participation in programs stressing aquatic or gentle aerobic (e.g., walking programs), or strengthening exercise may also be of

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benefit, although these modalities should be individualized to the patient's diagnosis, prior activity levels, desired activity levels, and overall preferences. Weight loss also is thought to be strongly indicated for patients who are either overweight or obese [4-25]. A few recent trials have suggested that weight loss reduces pain and morbidity [5,16,26-28].

Osteoarthrosis: Pharmacologic Management

Non-steroidal anti-inflammatory drugs (NSAIDs) are most commonly used for patients with OA. Chronic NSAID therapy may warrant ancillary use of proton pump inhibitors, H-2 histamine blocking agents, or misoprostol to provide prophylaxis against gastrointestinal adverse effects, especially among the elderly or those at increased risk of bleeding. The primary advantage of selective Cox-2 inhibitors is their lower risks of gastrointestinal side effects. Acetaminophen is less effective than NSAIDs; however, it may be jointly taken with NSAIDs for additive relief. Tricyclic antidepressants or dual reuptake inhibiting antidepressants (i.e., SSNRIs) may be of benefit for some patients. Clinicians should also take into consideration that many OA patients are older and have significant comorbidities, including renal impairment. Medications should therefore be carefully prescribed.

Osteoarthrosis: Role of Invasive Procedures

Invasive procedures are not indicated in the management of most osteoarthrosis patients unless the condition is unable to be satisfactorily controlled with other non-invasive treatments. In such cases, intraarticular injections with glucocorticosteroid are sometimes utilized, but provide no long-term benefit. However, glucocorticoid injections are not advised within 3 months of arthroplasty due to increased risk of infection. In advanced cases, joint replacements and other surgical procedures are often performed.

Osteochondritis Dissecans

Osteochondritis dissecans most commonly affects the knee, although other joints including the elbow, hip, and ankle are sometimes affected [29]. It is manifested by articular cartilage that dislodges or dissects from the underlying bone. Osteochondritis dissecans most commonly occurs in teenagers, although it can occur in adults. The cause of osteochondritis dissecans is unclear. However, there are important genetic risks [29,30]. Although sports activities, particularly in teenage years, also appear to be an important risk factor, there are no quality epidemiological studies of the association of osteochondritis dissecans with work. Consequently, osteochondritis dissecans will not be addressed further in this guideline [31,32,33,34,35,36,37,38,39,40,41,42,43].

Osteonecrosis (Avascular Necrosis)

Osteonecrosis occurs when the tenuous blood supply to the bone is interrupted. Osteonecrosis may result from traumatic or non-traumatic factors. The condition is painless in early stages, but when it advances, patients generally present with pain and limitation of motion. Pain most commonly localizes over the affected bone. This condition most commonly affects the head of the femur, but it can affect any bone. Pain in the lower

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extremity is usually exacerbated by weight bearing and relieved with rest. Both risk factors and management of knee osteonecrosis are largely extrapolated from quality evidence for treatment of osteonecrosis of the head of the femur (see Hip and Groin Disorders guideline). Systemic risks include glucocorticosteroids, alcohol, diabetes mellitus, and hemoglobinopathies. Localized knee risks include meniscal extrusion and arthroscopy complications [44]. Some cases are idiopathic.

Patellar Dislocation and Instability

The patella is subject to instability from congenital or inherited tendencies to dislocate [45,46,47,48] as well as trauma. Pain from dislocation is usually severe and associated with an inability to use the limb. Individuals with a congenital or inherited tendency to dislocate have usually dislocated their patella prior to reaching an employable age. The patella may dislocate with lesser force or stress over time, and recurrences are common. Surgical repair is performed on the medial patella femoral ligament. Other cases of patellar dislocation occur as a result of significant trauma (e.g., motor vehicle accident or fall). The patella may then be prone to recurrent dislocation after the initial dislocation, and a subjective feeling of instability may result. Strengthening exercises may be helpful. In most cases, particularly if recurrent, surgical repair is attempted.

Patellofemoral Joint Syndrome and Patellofemoral Joint Degenerative Arthrosis (Including Chondromalacia Patellae)

Patellofemoral joint syndrome is a diagnostic category that includes patients with pain thought to be primarily from the patellofemoral joint or the anterior aspect of the knee. Some of these patients are thought to have degenerative joint disease that is focused on that aspect of the knee joint, although they may also have degenerative changes in other parts of the knee joint. Theoretical mechanisms are controversial. When pain arises from arthrosis in the patellofemoral joint, then nonsurgical treatment is comparable to other arthrosis reviewed above. However, when there is evidence of quadriceps muscle weakness, specific strengthening exercises for that muscle (e.g. ,vastus medialis obliques) are usually prescribed.

Patellar Tendinopathy

Patellar tendinosis, which affects the patellar tendon, is sometimes referred to as “jumper’s knee.” This usually arises from high-force activities on a stereotypical basis, direct trauma, and/or as a degenerative condition. Patellar tendinosis is usually treated with NSAIDs and exercises. Knee appliances (e.g., sleeve, strap) are also sometimes used as are heat, ice, and topical treatments. Severe cases may rupture (see Patellar Tendon Tears).

Patellar Tendon Tears

Patellar tendon tears usually occur with either a high-force event or an accident, but can result from severe patellar tendinosis. They are treated with surgical repair and rehabilitation; low grade partial tears may be treated non-operatively.

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Sprains and Tears of the Cruciate Ligament (Anterior and Posterior)

Cruciate ligament sprains and tears are sprains or partial or complete tears of the ligaments connecting the femur to the tibial plateau that generally occur as the result of high-force injuries from sports, accidents, or falls. In some cases involving less trauma with rotational component or rupture is believed to occur because of prior injury and weakness of the ligament tissue. Symptoms include pain and instability. A large effusion may occur with ruptures. Partial tears are usually treated with NSAIDs, ice, and may involve exercises in a formal therapy program. Complete tears of the anterior cruciate ligament are sometimes surgically reconstructed, although randomized trials demonstrate that most people do not require surgery to obtain comparable results. Complete tears of the posterior cruciate are usually treated non operatively with bracing and exercise, although sometimes they are treated surgically.

Sprains and Tears of the Collateral Ligaments (Medial and Lateral)

Collateral ligament sprains and tears are sprains and partial or complete tears of the ligaments connecting the lateral femur to the tibia (lateral collateral ligament) or medial femur to the tibia (medial collateral ligament). By definition, these are high-force injuries and may occur during sports, accidents, trips, slips or falls. Pain is localized to the affected ligament. The medial collateral ligament may be accompanied by a medial meniscal tear due to shared fibers between these two anatomical parts resulting in a common occurrence of co-injury. These may be classified as first degree (mild), which consists of pain but no laxity; second degree (moderate), which consists of pain, possible swelling, and some laxity compared with the unaffected knee but no complete tearing; and third degree (severe), which consists of complete tearing of the ligament. Treatments usually consist of NSAIDs and ice or heat, knee hinged knee braces or support sleeves in the acute phase, and may involve exercises in a formal therapy program. Isolated complete tears of the medial collateral ligament may be treated nonoperatively.

Synovitis

Synovitis refers to inflammation of a synovial membrane. Aside from inflammatory arthritides, infections, and crystal deposition diseases, in most cases, there are no classic symptoms and signs of inflammation. Synovitis is usually painful, especially with motion. Fluctuating swelling may occur due to effusion within the knee joint space Treatments usually consist of NSAIDs, compression or elimination of physical exposures (especially direct pressure if thought to be problematic), and often ice or heat. Occasionally, glucocorticoid injections are used to decrease the synovial tissue reaction.

IMPACT

Of the many knee disorders reviewed in this guideline, few have been comprehensively studied using high-quality epidemiological methods. For example, while robust prevalence, incidence, and cost estimates are available for osteoarthrosis and meniscal and cruciate ligament tears, robust, population-based data on the burden of other knee disorders is largely unavailable.

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Meniscal and anterior cruciate ligament (ACL) injuries are the two most common knee injuries. The incidence rate of ACL tears is 68.6/100,000 [49], with peak rates in males ages 19-25 yrs of 241/100,000 and 227.6/100,000 among females ages 14-18 years. This incidence rate results in an estimated ~226,000 in the US population. Most of the injuries, especially in younger adults and teenagers, are thought to be sports-related, although there is a dearth of quality epidemiological studies. MRIs have documented that meniscal degeneration becomes ubiquitous with age, so the true incidence rate of meniscal injuries is exceedingly difficult to measure; instead, estimates of symptomatic tears has been estimated at 60-70 per 100,000 [50,51].

Osteoarthrosis (OA) is common, and the incidence rate increases sharply with age and obesity. It is associated with significant morbidity and cost. OA affects 13.9% of adults aged 25 years and older and between 33.6 to 46% of adults over age 65. By age 75, the prevalence rate rises above 50%, thus becoming "normal" [52]. Nearly 66% of obese adults will develop painful knee OA over their lifetime [53,54]. Of the arthritis-related procedures that require hospitalization, 35% are due to hip and knee replacements. Job-related costs for OA overall are $3.4 to $13.2 billion per year with an average patient out-of-pocket direct expense of $2,600 per year. Thirty-six percent of those affected with arthritis report activity limitations and participation restrictions [55]. The American Joint Replacement Registry data how the rate of arthroplasty is growing and there were 1.3 million total knee joint replacements reported in 2022 [56].

According to the U.S. Department of Labor's Bureau of Labor Statistics, there were 66,650 workplace knee injuries, nearly all of which were traumatic (66,260). A total of 2,560 were knee fractures and 1,570 were dislocations. There wee 3,840 "cartilage fractures and tears" and meniscal tears were 3,820. There were 12,430 sprains and 10,230 strains. 28,410 knee injuries involving days away from work in 2020 [57].

BASIC PRINCIPLES AND DEFINITIONS

Acute, Subacute, and Chronic Pain: For the purposes of identifying interventions at different stages of diseases, acute pain is defined as pain of up to 1 month, subacute is pain from 1 to 3 months, and chronic is pain of more than 3 months duration (see Chronic Pain guideline for additional information).

Active Therapy: The term “active therapy” is commonly used to describe treatment that requires the patient to assume an active role in rehabilitative treatment. Although there is no one specific treatment defined by this term, it most commonly includes therapeutic exercises, particularly aerobic activities and muscle reconditioning (weight lifting or resistance training) [58]. Some authors include active stretching and treatment with psychological, social and/or educational components requiring active participation from the patient [59]. Passive modalities are not included in "active therapy."

Active Exercise Therapy: Therapy that typically consists of cardiovascular training and muscle strengthening [60,61], though it may also include progressive or occasionally even active stretching in those with substantially reduced ranges of motion. In knee rehabilitation, it may also include motor learning and dynamic motor imagery [62,63,64]. Active exercise therapy is used as a primary treatment for chronic pain, is frequently initiated in

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the course of treating subacute pain, and is a primary treatment after various surgeries. The goal of active exercise therapy is to improve function [60]. The word “active” is used to differentiate individualized exercise programs designed to address and rehabilitate specific functional, anatomic or physiologic deficits from passive treatment modalities or from forms of “exercise” that require very little effort or investment on the part of the patient or clinician. Passive modalities are not included in "active exercise therapy."

Bursae: Fluid-filled sacs within the body which provide lubrication and cushioning in areas where muscles move over bony projections. Inflammation of a bursa may occur and is referred to as bursitis (see Bursitis). Commonly affected bursae include the infra-patellar, pre-patellar, suprapatellar and anserine bursae. These bursae lie in front of the tibial tuberosity, anterior to the patella, above the patella, and between the bone and adductor tendons along the medial knee, respectively.

Collateral Ligament: Ligaments connecting the lateral femur to the fibula (lateral collateral ligament) or the medial femur to the tibia (medial collateral ligament).

Cruciate Ligament: Ligament connecting the center of the distal femur to the center of the tibial plateau. There are two cruciate ligaments per knee – the anterior and posterior.

Delayed Recovery: Defined as an increase in the period of time between the onset of the injury and/or illness and the patient’s return to work or usual activities relative to the expected recovery time. Expected recovery takes into account reasonable expectations, disorder severity, age, and treatments provided.

Enthesopathy: Disorder of the muscular or tendinous attachment to bone.

Functional Capacity Evaluation (FCE): A comprehensive battery of performance-based tests used to attempt to assess an individual’s ability for work and do activities of daily living [65]. An FCE may be done to identify an evaluee’s ability to perform specific job tasks associated with a job (job-specific FCE) or his or her ability to perform physical activities associated with any job (general FCE).

Functional Improvement: Entails tracking and recording evidence that the patient is making progress towards increasing his or her functional state. Use of objective data is most preferable (e.g., walking distance), followed by validated tool(s) to track functional improvement.

Functional Restoration: A term initially used for a variant of interdisciplinary pain alleviation, or at least amelioration, characterized by objective physical function measures, intensive graded exercise and multi-modal pain/disability management with both

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psychological and case management features [66,67,68,69,70,71,72]. The term has become popular as a philosophy and an approach to medical care and rehabilitation. In that sense, functional restoration refers to a blend of various techniques (physical and psychosocial) for evaluating and treating the chronic non-malignant pain patient, particularly in the workers' compensation setting (see Chronic Pain guideline).

Iliotibial Band: Fibrous connection between the ilium of the pelvis to the tibia. The iliotibial band syndrome involves pain mostly in the lateral knee joint.

Knee Joint: The knee joint is a synovial hinge type joint based on the articulation of the distal femur and the tibia of the calf. Four ligaments hold the femur to the tibia – the medial and lateral collateral ligaments and the anterior and posterior cruciate ligaments.

Knee Pain: Pain originating from the knee is usually focally felt in the knee joint. However, some cases are experienced with pain primarily in the hip region (e.g. obturator nerve pain). Anterior knee pain is commonly due to patellofemoral joint pain, patellar tendinopathy, and quadriceps strains. Medial joint pain is often caused by medial collateral ligament (MCL) sprains, medial meniscal tears, medial compartment OA, groin strains, and anserine bursitis. Lateral joint pain is frequently due to lateral collateral ligament (LCL) sprains, lateral meniscal tears, lateral joint OA, and iliotibial band syndrome. Posterior knee joint pain is commonly due to hamstring strains, calf strains, Baker's cysts, hyperextension injuries, and popliteal arterial disorders. Other patients have proximally or distally radiating pain. Pain in the knee may also be due to referred pain from cardiovascular or metastatic processes, lumbar disc herniation with nerve impingement, lumbar spinal stenosis, or arterial insufficiency.

Meniscus: The meniscus is a semilunar ("C-shaped") fibrocartilaginous structure. The medial meniscus covers approximately 50-70% of the medial tibial plateau, while the lateral meniscus covers approximately 75-93% of the surface of the lateral tibial plateau and helps distribute weight from the respective femoral condyle evenly, while also helping with glide and stability.

Pain Behavior: Verbal and non-verbal actions (e.g., grimacing, groaning, limping, using pain relieving or support devices, requesting pain medications, etc.) which communicate the concept of pain to others.

Passive Modality: Various types of clinician-administered treatments in which the patient is passive. These treatments include medication, injection, surgery, allied health therapies (e.g., massage, acupuncture, and manipulation), and various physical modalities such as hydrotherapy (e.g., whirlpools, hot tubs, spas, etc.), ultrasound, TENS, other electrical therapies, heat and cryotherapies.

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Primary Prevention: Primary prevention involves preventing the condition or risk factor from developing (e.g., physical activity programs to prevent obesity).

Rehabilitation: Rehabilitation is used in these guidelines to mean physical medicine, therapeutic and rehabilitative evaluations, and procedures. Rehabilitation services are delivered under the direction of trained and licensed individuals such as physicians, occupational therapists, and physical therapists. Sometimes mental health professionals are incorporated into the treatment team, particularly for select chronic pain patients. Jurisdictions may differ on qualifications for licensure to perform rehabilitative evaluations and interventions.

Secondary Prevention: Secondary prevention involves reduction in the exposure or risk factor after the risk factor has already developed, but before the disease has manifested (e.g., use of fall protection equipment to prevent hip fractures).

Sprain: Disruption of a joint's ligaments. Examples in the knee include sprains of the medical or lateral collateral ligaments or anterior or posterior cruciate ligaments (see Cruciate and Collateral Sprain).

Strain: Disruption of a muscle or myotendinous junction, usually from a high force or unaccustomed exertion(s). It may also occur during an accident. This term is occasionally used casually to describe non-specific muscle pain in the absence of knowledge of an anatomic pathophysiological correlate. In the knee region, examples include hamstring, calf, and quadriceps strains (see Hamstring, Calf, Quadriceps Strain).

Stress Fracture: Fractures that occur mainly due to unaccustomed, forceful use. Stress fractures may also occur due to significant increases in physically demanding activity, such as an employee transferring to a job involving substantially greater levels of force, often on a repeated basis. Treatment is generally activity modification to preclude high force use until resolution.

Synovial Membrane: The membrane surrounding the entire knee, including the medial, lateral, and patellofemoral joints. The synovial membrane may become inflamed, leading to synovitis (see Synovitis).

Synovial Plicae: Remnants of the divisions of the knee compartments. These are thought to be involved in inflammation and irritation, termed "plicae syndrome."

Tendinosis: Occurs when the collagen fibers in the tendon become damaged.

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Tenosynovitis: Tenosynovitis refers to inflammation of a tendon sheath, although in most cases, there are not classic symptoms and signs of inflammation. Classic inflammation may occur with inflammatory or crystalline arthropathies or infectious agents.

Tertiary Prevention: The amelioration of the condition after it has already developed. For example, after a patient has osteonecrosis, precluding them from diving, which may be associated with dysbaric osteonecrosis, is a method of tertiary prevention.

Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC): A common knee outcome measure for osteoarthrosis of the knee, other than standard and VAS pain ratings. It combines subjective ratings of pain with measures of activity levels, stiffness, physical function, social function and emotional function [(73)].

RISK AND CAUSATION

Acute occupational knee injuries are related to a specific acute traumatic event. The location of that event determines work-relatedness, and work-relatedness in those cases is usually non-controversial. Most jurisdictions also request an opinion from the physician as to whether a disease or disorder should be considered as work-related for the purpose of a workers' compensation claim. Physicians need to remember that their role is to supply opinion, and that the "medical/scientific answer" and the "legal answer," as determined by the regulations and case law precedents in a particular jurisdiction (workers' compensation system), are different (see Work-relatedness guideline). However, there are few quality epidemiological studies that address work-related knee disorders. Thus, aside from these specific circumstances (e.g., occupational fractures and other acute trauma, meniscal tears from acute trauma, osteonecrosis from barotrauma, prepatellar bursitis in a roofer), most opinions are speculative.

BURSITIS

Bursitis may be caused by multiple disorders and exposures. These include crystal deposition diseases, inflammatory arthritides, and infections. Crystal deposition diseases and inflammatory arthritides are nonoccupational and are not discussed further. Infections that are due to either a discrete work-related injury (e.g., laceration) or as a consequence of a worker's compensation-paid surgery are considered occupational, noncontroversial, and are not discussed further. Direct, discrete trauma (e.g., falling on the knee joint) is also considered occupational and is not discussed further. The remainder of this discussion concerns potentially work-related exposure mechanisms.

A large survey of 3,710 randomly included workers from a region of France that included a standardized physical examination found a prevalence of 0.6% in men and 0.2% in women [(74)]. The highest prevalence was in the construction sector. Infrapatellar bursitis appears to occur most commonly in the setting of kneeling activities [(75)]. This is considered work-related and is not usually controversial. The risk is thought to be highest among those with unaccustomed kneeling. Similarly, prepatellar bursitis in the context of discrete trauma or kneeling is considered work-related [(76,77,78,79)]. However, for other cases of bursitis, including where there is no kneeling and no discrete trauma, there are no quality studies of occupational factors.

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Anserine bursitis appears to occur both in the presence and absence of trauma. There are no quality studies of occupational factors, and one study reported the only associated factor found was a valgus knee deformity [80]. Another study found 20% of patients with knee osteoarthrosis have pes anserine bursitis [81], while a second study estimated the rate among knee OA patients at 2.2% [82]. In settings where significant trauma has occurred to precipitate the bursitis, work-relatedness is not controversial. In the absence of trauma, a theory may be constructed whereby physical factors such as unaccustomed forceful use of the knee may cause the condition; however, this is speculative.

DISLOCATIONS AND FRACTURES

Patellar dislocations are, absent congenital abnormalities (e.g., anatomic variants including increased Q angle; ligamentous laxity), consequences of significant trauma. The mechanism of the trauma determines whether the condition is work-related. A population-based prospective study in Olmsted County, MN reported an age and sex-adjusted annual incidence rate of first patellar dislocation of 23.2/100,000 person-years, mean age of dislocation of 21.4 +/- 9.9 years, with the highest rates among 14- to 18-year-olds and equivalent rates for both sexes [83] Interestingly, the rate declined over the study period of 1990-2010, potentially aligning with reductions in overall sports and physical activity. Another study estimated an incidence rate of 2.29/100,00 but was based only on emergency department visits; this study found 51.9% occurred in a sports context [84]. A high rate of dislocation has been reported in the US military, particularly affecting the youngest recruits [85].

Risk of redislocation after a first-time lateral patellar dislocation is reportedly 33.6%, with higher risks among those younger (OR=2.6), open physes (OR=2.7), trochlear dysplasia (OR=4.2), elevated tibial tuberosity-trochlear groove distance (OR=2.9), and patella alta (OR=2.4) [86].

In those with recurrent dislocations, there is frequently an inherited or congenital abnormality with a propensity towards recurrences. In situations where there is a congenital abnormality, dislocation may occur in the context of an “event at work” and produce a controversy regarding work-relatedness that likely will be determined largely based on the specific statutory definition of work-relatedness in the setting of pre-existing, non-occupational conditions.

Knee fractures are consequences of significant trauma. The mechanism of the trauma determines whether the condition is work-related.

ILIOTIBIAL BAND SYNDROME

Iliotibial band syndrome is believed to occur in susceptible individuals with exposure to forceful, repeated movement of the iliotibial band over the lateral femoral condyle with resultant friction [87,88,89,90,91,92,93]. This disorder has been reported mostly in discrete, very physically active populations, including runners, military recruits, weight lifters, bicyclists, and downhill skiers [90,92,94-112]. Increased risk also occurs during rehabilitation after arthroplasty [113].

Quality epidemiological studies are absent, but purported risk factors include increased activity, genu varus, leg length discrepancies, running surface and shoe wear [88,114,115]. The results are thought to include tendinopathy-like changes involving the iliotibial tract with accompanying inflammation of the lateral synovial recess [88,90,92,116-122]. This entity is

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considered a disease, rather than an acute injury. Most case series occur in athletes, particularly in runners, weight lifters, bicyclists, and downhill skiers, and among military recruits [87,89-110,123,124,125,126]. However, quality epidemiological studies are absent and risk factors are unclear. As there are no quality epidemiological studies, the condition has not been documented as occupational.

OSTEOARTHROSIS OF THE KNEE

Population-based surveillance data from NHANES show that knee osteoarthrosis is quite common in the United States, being strongly linked with age. Severe radiographic findings are found nearly twice as often in women compared with men (12.9% vs. 6.5%) [127]. Of those at least 60 years of age, the probability of radiographically normal knee joints was only 52.7%. However, the data were from NHANES III, 1988-1994; thus, current estimates are likely much higher given the strong increases in obesity over the past 30 years. The CDC estimates that 33 million US adults have osteoarthrosis in any joint [128]. A body mass index of more than 30 kg/m^2 more than doubled the risk of radiological findings in the NHANES III data.

An estimated 12% of cases of symptomatic knee osteoarthrosis are considered to be posttraumatic, including after fracture [129-136]. An isolated torn meniscus is associated with a 6.3-fold risk of development of knee OA [21,137,138,139]. Partial meniscectomy is associated with an approximately 7.8-fold risk while arthroscopic partial meniscectomy is associated with an approximately 4.8-fold risk of knee OA development [139]. Among those with knee osteoarthritis who undergo arthroscopic meniscectomy, there is a threefold increased risk of subsequent knee arthroplasty [140]. A population-based study on worker's compensation claims who underwent meniscectomy reported a 2.2-fold odds of subsequent total knee arthroplasty [141]. ACL surgery confers an ~4.2-fold risk of developing knee OA [139,142,143,144]. The mechanism of that trauma is usually believed to be responsible for the osteoarthrosis, particularly as the magnitude of risk is generally considerable (pooled odds ratio was estimated at 3.86 [95% CI: 2.61-5.70] [2]), which often determines work-relatedness. However, the majority of cases of meniscal tear have no significant traumatic history and thus causation is often unclear.

Knee OA is generally classified as non-inflammatory, in contrast with rheumatoid arthritis and other inflammatory arthritides. Yet, there are many different inflammatory mediators and biomarkers that are detectable in joints or systemically in affected individuals, including collagenase, tissue inhibitor of metalloproteinases, proteoglycan fragments, aggrecan, stromelysin-1, decorin, adiponectin, leptin, biglycan, lumican, keratocan, fractalkine, interleukin-1alpha, interleukin-1beta, interleukin-2, interleukin-5, interleukin-6, interleukin-13, interleukin-18, interferon gamma-induced protein 10, tumor necrosis factor-alpha, chemokine ligand 2, macrophage derived chemokine, macrophage inflammatory protein-1beta, monocyte chemoattractant protein-1, CRP, complement C31 and C5b-9 [145-157], and hyaluronic acid, which has predicted earlier progression of OA [158]. Weight loss has been shown to reduce those same inflammatory markers among knee osteoarthrosis patients [17]. Some cytokines have been inversely associated with knee osteoarthrosis, including interferon gamma inducible protein 10, adipsin, interferon gamma inducible protein 10, and eotaxin [157].

Age is a well documented and robust risk factor for knee osteoarthrosis [2,159-175]. Obesity has also been shown to be another unusually robust risk factor for osteoarthrosis of the knee

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[2,23,167,168,172,175-196], as it is for other joints throughout the body [167,197,198,199,200,201] (see Hip and Groin Disorders and Hand, Wrist, and Forearm Disorders guidelines). That obesity is associated with osteoarthrosis of the upper extremity shows the mechanism is at least partially unrelated to weight bearing. Additionally, weight loss appears to result in lower risk for osteoarthrosis [179,202,203,204], reduces biomarkers of worse disease [17,205,206], and improves prognoses of patients with osteoarthrosis [17,203,207-211].

Genetic factors are reportedly strong [185,212-217], and evidence suggests that these factors are prominent among patients with young age at onset [218]. The knee joint is frequently involved in generalized osteoarthrosis, has genetic links and is associated with faster progression [163,189,219-228]. Heberden's nodes are considered a sign of generalized osteoarthrosis and increase risk of knee degenerative changes by 2-3 fold in most studies [229,230], although one study found a 6-fold increased risk over a 12-year period [189], and another found hand osteoarthrosis conveys a 50% increased risk for knee OA [231].

Muscle weakness is thought to increase risk of knee OA [232-239] and forms a basis for one of the tertiary preventive interventions for which there is some quality evidence of efficacy (see exercise section). Leg length discrepancy is also an apparent risk factor [240], as is knee malalignment [189]. Bone marrow edema is another reported risk [241].

Job physical factors have not yet been studied in high quality epidemiological studies. The overall quality of evidence determination by the WHO/ILO Joint Estimates of the Work-related Burden of Disease and Injury was deemed of "low quality" and with "moderate risk of biases" [242]. Scant prospective cohort studies have suggested a 2-fold risk of knee OA associated with "heavy manual occupations" but no association among women [243].

Purported associated factors have included kneeling, squatting and lifting. However, results have been somewhat inconsistent [177,192,244], concerns about biases have been raised [245], risks are nearly always low magnitude when positive, and nearly completely based on retrospective methods without measured job factors [79,137,190,242,243,246-257]. However, some studies reported interactions of risk factors, and this suggests further need for study [142,190]. Of all risks, kneeling appears to be most consistently associated with knee OA [79,190,242,243,249,255,257,258]. A registry study from Sweden has suggested increased risk among farmers, construction workers, and firefighters, while risks were not elevated among numerous other occupational groups [250,251]. Others have suggested no increased risk of knee OA among farmers [259].

Numerous studies of runners have been performed with a basic presumption of risk due to high force use of the knees; however, nearly all studies including long duration cohort and other studies have been negative [260-265], and a meta-analysis reporting an overall protective effect of running [266,267], while another review found a protective effect of recreational running, with higher rates in patients who are sedentary or competitive runners [268]. There also has been suggestive evidence of thicker cartilage among runners [269] and in some animal models [270]. Mixed sports and power sports have reportedly led to earlier knee OA, but not endurance sports [260].

A few other studies may also be of interest including a lack of differences in injuries between artificial turf and natural grass in a prospective cohort study of soccer players [271]. A comparative study of cartilage from the apparently unaffected side in unicompartmental OA patients found the cartilage was inferior to the cadaveric controls [272], suggesting the cartilage of affected patients is inherently defective.

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PATELLAR TENDINOPATHY

Sports, particularly those involving jumping or landing and explosive forces (e.g., basketball, volleyball, rugby, soccer, pickle ball) have been linked to patellar tendinopathy in epidemiological studies [273,274,275,276,277]. Discrete accidents may also contribute to patellar tendinopathy. One report also suggested an increased risk among military recruits [278]. In one study that performed MRI examinations of 176 women aged 40-67 years, 30% of patients had findings of patellar tendinopathy, with a modestly higher risk (OR: 1.65) among those with higher levels of physical activity [279]. Because forceful use may contribute to the condition [279], patellar tendinopathy may be occupational in some circumstances, especially when involving high-force quadriceps contraction. However, no quality epidemiological studies have identified occupational risk factors. Repeated, high force stereotypical use is believed to be a risk (i.e., "jumper's knee").

PATELLOFEMORAL SYNDROME

A systematic review reported the prevalence of patellofemoral syndrome to be 22.7%, with high rates among military recruits, runners, and adolescent amateur athletes, especially among females in all settings [280]. The condition is particularly common in athletically-active youths [281] and with patellar malalignment. Squats are reportedly a risk [282], although this is not likely the mechanism among runners. There are reports that the condition is most common in those with high knee demands including military recruits [283,284] and among those kneeling [79,285]. However, there are no quality occupational epidemiological studies and none measuring work exposures. Chondromalacia patellae was previously thought to be a distinct entity [286], although the term anterior knee pain is now used.

SPRAINS, STRAINS, AND TEARS

Collateral ligament sprains are thought to be consequences of significant trauma. The mechanism of the trauma determines whether the condition is work-related. Cruciate tears and sprains are largely attributed to the consequences of significant trauma or rotational injury [287,288,289,290]. The mechanism of the trauma determines whether the condition is work-related.

A population-based study of Olmsted County reported an age and sex-adjusted incidence rate of ACL tears between 1990-2010 of 68.6/100,000 person-years, 48% higher risk among males, highest risk among adolescents and young adults, and a higher rate of surgical repair over the 21-year period [49]. A Swedish registry study also reported an incidence rate of 80/100,000 [291]. Re-tears after surgical reconstruction have been estimated at 7% [292].

Complete disruptions of the cruciate ligaments are most commonly experienced in athletics, associated with rotational forces, as well as acute discrete, forceful traumatic events [293-313].ACL tear rates among military are reportedly quite high, at 3.09/1000 person-years for males and 2.29/1000 person-years for females [314]. There are no quality epidemiological studies among typical working populations.

There are sharply higher risks for the subsequent development of osteoarthrosis among those having sustained an ACL tear, estimated at 4.2-fold for an isolated ACL tear and 6.4-fold if there also is a meniscal tear. However, in one systematic review, 98% of 1 million patients had had surgical reconstruction [139].

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Hamstring, calf, and quadriceps strains involve myotendinous strains (time and force dependent) in the respective muscle-tendon unit. Symptoms are usually acute in onset and these injuries are considered more analogous to acute injuries than diseases, although repeated, unaccustomed use may have precipitated the event. Thus, the nature of the forceful unaccustomed or supramaximal use determines whether the condition is work-related.

Meniscal tears are highly prevalent [225,226,315-323]. The incidence rate of meniscal tears has been estimated at 60/100,000 [324], with the highest risk in the mid-teenage years [325].

The mechanism of injury will determine whether the meniscal tear is considered work-related. Acute, large meniscal tears occurring with a discrete traumatic event are usually considered as being consequences of that trauma [323]. The mechanism of the trauma normally determines whether the condition is work-related. On the other end of the spectrum, there are cases of degenerative-appearing meniscal tears without a discrete traumatic event. In such cases, these tears are diseases. There is little quality epidemiological evidence that they are work-related, although some have theorized a relationship [326-330]. High rates among the military have been reported [331]. A systematic review with meta-analysis found associations with multiple occupational factors, including kneeling (effect size [ES] 2.15), squatting (ES 2.01), climbing stairs (ES 2.28), lifting and carrying weights >10 kg (ES 1.63), lifting and carrying weights >25 kg (ES 1.56), playing professional soccer (ES 5.22), being a hard coal miner (ES 5.23), and being a flooring installer (ES 1.99) [332]. There are many cases occurring between the two extremes noted above, and work-relatedness is often unclear.

Quadriceps, gastrocnemius and soleus strains are thought to be true muscular strains (i.e., disrupted myotendinous junctions). These problems are usually (time and force dependent) precipitated by a high-force maneuver, including explosive sports injuries in sprinting, football or soccer [333,334,335], with supra-maximum voluntary contraction use. Prior injury is likely the greatest predictor of future risk. Patients have pain exacerbated by use, stiffness, and weakness.

INITIAL ASSESSMENT

The knee should be carefully evaluated with a history (mechanism of injury), physical examination, and focused diagnostic testing. A complete physical exam is recommended, since pain can be referred, particularly from the back or hip to the knee joint. The initial knee examination or consultation should focus on the detection of conditions that are remediable and “red flags” (e.g., fractures, osteonecrosis, cancer, or septic arthritis).

The physician performing an initial evaluation of a patient with knee symptoms should aim to develop an appropriate differential diagnosis. A careful, thorough history and focused physical examination is required (see General Approach to Initial Assessment and Documentation). A review that not only focuses on the knee, but also addresses the hip, foot, spine, abdomen, is necessary. The examination of the patient with knee symptoms should focus on the knee joint and relevant neighboring structures. Findings of the medical history and physical examination can alert the physician to other non knee-related pathology. Certain findings, referred to as “red flags,” raise suspicion of serious underlying medical conditions (see Table 1). Potentially serious disorders include infections, tumors, and systemic rheumatological disorders.

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Knee disorders may be classified into one of four somewhat arbitrary and overlapping categories (examples):

- **Potentially serious knee conditions:** fractures, dislocation, infection, neurovascular compromise, tumors.
- **Mechanical disorders:** derangements of the knee more commonly related to acute trauma, such as ligament sprains and tears, myotendinous strain, and some meniscus tears.
- **Degenerative disorders:** mostly consequences of aging, including osteoarthrosis, tendinosis, and most meniscal tears.
- **Nonspecific disorders:** occurring in the knee and suggesting neither internal derangement nor referred pain.

TESTING PROCEDURES

Special studies are not needed to evaluate most knee symptoms (see Table 2), unless a period of conservative care and observation has failed to lead to resolution or improvement of symptoms. Two commonly used criteria for radiographs are the Ottawa rule and the American College of Radiology (ACR) rule, both of which have 98-100% sensitivity but low specificity of ~40-50%, as is common for screening tests [336-341]

Using the Ottawa rule, the criteria to perform x-rays for acute knee injuries include any of the following:

- Age 55 years or older
- Tenderness at the head of the fibula
- isolated tenderness of the patella
- Inability to flex the knee greater than 90 degrees
- Inability to bear weight both immediately and at the initial clinician evaluation

The ACR's most recent appropriateness criteria include the following clinical parameters as predicting the absence of significant fracture. These parameters may be used to support the decision *not* to obtain a radiograph following knee trauma, although the decision rests with the treating physician who has completed a history and physical exam:

- patient is able to walk without a limp;
- patient had a twisting injury and there is no effusion.

The clinical parameters for ordering knee radiographs following trauma, as recommended by the ACR as "usually appropriate," are significant trauma (e.g., motor vehicle crash, knee dislocation) or any of the following: joint effusion, focal tenderness (e.g., over fibular head or patella), or inability to bear weight.

DIAGNOSTIC CRITERIA

The criteria presented in Table 3 follow the clinical thought process, from the type of illness or injury, to symptoms and signs of a particular disorder to, finally, test results (if any tests are indicated).

HISTORY

The initial evaluation of patients with knee pain should include a thorough medical history. Although knee symptoms are generally more accurately attributed to the knee joint than the hip joint, some cases of knee joint pathology may present with hip pain (see Hip and Groin Disorders guideline). The clinical phenomena of primary hip and pelvic region

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pathology referring pain to the knee is well documented and appears to be particularly prevalent in the pediatric population. This may include delayed diagnoses of serious pelvic region pathology such as osteogenic sarcoma in younger soldiers. Disorders such as Legg-Calve-Perthes and slipped capital femoral epiphysis may be associated with primary complaints of knee pain. These conditions might be seen in younger workers. Similarly, many patients with a chief complaint of hip pain actually have a knee disorder that is usually osteoarthrosis. Clues to the origin of symptoms can be determined with a careful patient history as primary hip pathology typically is perceived in the buttocks, anterior inguinal region, thigh and occasionally in the foot and ankle. Hip pathology presents as difficulty crossing legs, laying on the hip and restricted internal rotation, while knee pathology presents as difficulty climbing stairs, kneeling onto the knee, and bending the knee to get in and out of the car. Consequently, the hip, pelvic region and lumbar spine should be examined thoroughly in any instance of thigh or knee pain that is not clearly an isolated acute knee injury.

A complete occupational history, including a description of the mechanism of injury, is also necessary to assist the patient with successful accommodation and rehabilitation, as well as to determine work-relatedness. Asking the patient open-ended questions, such as those listed in the Medical History Questionnaire, allows the clinician to gauge the need for further discussion or specific inquiries to obtain more detailed information (see also General Approach to Initial Assessment and Documentation guideline).

PHYSICAL EXAMINATION

Objectives of the physical examination of the knee include defining physical abnormalities, narrowing diagnostic considerations, and developing and focusing an effective, specific treatment plan. In order to align an intervention strategy with deficits such as impaired strength, or movement balance, the examination should first reveal the impairments. Examination of knee includes active and passive ranges of motion and accessory movements. Muscle strength and flexibility should be revealed through valid testing. Coordination, balance, and fall risk should also be assessed. Special tests for specific pathologies are often only a small aspect of the examination and may be overall less important to nonsurgical management of the knee disorder. Special tests are more helpful when there is clear evidence that the pathology revealed is better managed by a process other than restoring normal movement, strength, flexibility, and coordination to the knee.

Physical examination data, including vital signs, should be reviewed for potential inferences about infectious or neoplastic etiologies of knee symptoms. The physical examination should begin the moment the physician sees the patient. Observing how the patient sits, walks, and moves is extremely important. It is also helpful to have the patient demonstrate what positions caused or seem to provoke the symptoms.

Guided by the medical history, the physical examination includes:

- general observation of the patient, including stance and gait, and how the patient changes positions (monitoring for pain behavior during range of motion (ROM) and posture changes often offers a clue to the origin of the problem);
- regional examination of the knee and testing for specific knee disorders;

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- examination of organ systems related to appropriate differential diagnoses, including a neurological examination.

Much of the knee examination is not purely objective. There is an element of patient cooperation when determining strength or active range of motion, and most maneuvers require a subjective statement of pain to be considered positive. It is often helpful to assess patients' capabilities in the clinic to follow in subsequent clinic visits. These may include:

- walking distance and ability to climb stairs (observe, if possible, and inquire about any progress);
- repeated toe raises (number able to perform), heel walking (distance), and squats (number);
- sensory examination findings (e.g. pin prick, using monofilaments).

The use of validated functional assessment tools is recommended, if possible, to assess capabilities. Active involvement of the clinician in evaluating patients' function is believed to be helpful in facilitating patients' recoveries [342].

Physical Examination for Specific Diagnoses

Physical examination findings vary based on the acuity and severity of the disorder. In general, conditions that arise acutely present with more pronounced physical examination findings. Patients with long-standing conditions may have less prominent physical examination findings. The most commonly used physical examination maneuvers are described below. In addition, there are other examination maneuvers and techniques, including performance of maneuvers under anesthesia [343-361]. It is suggested that the examiner become familiar with a specific set of maneuvers rather than an entire battery.

Pes Anserine Bursitis

Tenderness over the pes anserine bursa is usually present [362,363]. In contrast with other types of bursitis, there is usually no palpable swelling or warmth [80,362,364].

Bursitis (Infrapatellar, Prepatellar, Suprapatellar)

Swelling in the affected bursa(e) is present [365,366,367]. The affected bursa may be slightly warm, but is generally minimally tender or non-tender. Moderate or severe pain or tenderness, overlying warmth, and erythema raise the probability of septic bursitis [367,368]. Crystal arthropathies may affect the bursae, but are rare, particularly in the infrapatellar or prepatellar bursae.

Collateral Ligament Sprains and Tears (MCL and LCL)

Collateral ligament sprains present with focal tenderness over the specific ligament [369,370]. Increased pain with stressing the ligament (i.e., valgus stressing for the medial collateral

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ligament and varus stressing for the lateral collateral ligament) is consistent with a ligamentous sprain [371,372]. Patients with complete tears have tenderness over the normal location of the ligament, and valgus or varus stressing reveals widening of the joint line [369,371-373].

Cruciate Ligament Tears and Sprains

Cruciate ligament tears generally have effusions that may be sizable, particularly if acute [374-377]. Joint tenderness may be present. Joint laxity is the major clinical finding and may be detected with Lachman's maneuver which is performed recumbent, with the knee flexed 20° and the examiner pulling the shin forward. If an ACL tear is present, there is greater movement than normal and compared with the other knee and with a soft endpoint [355,371,378,379,380,381]. The anterior drawer sign is performed with the knee flexed 90° and shin pulled forward, with greater movement than normal and compared with the other knee indicating an anterior cruciate ligament tear. The posterior drawer sign is performed with the knee flexed 90° and shin pushed backwards, with greater movement than normal indicating a posterior cruciate ligament tear [380,382,383]. Sprains without complete tears may present with some laxity in the drawer signs, but generally with hard endpoints. This test may only be adequately performed under anesthesia [384]. A systematic review with metanalysis found the most sensitive tests were the anterior drawer (83%), Lachman (81%) and Lever (83%) signs, while the pivot shift had poor sensitivity (55%) but the highest specificity (94%) [385]. Pivot shift test requires patient cooperation but provides high specificity and sensitivity.

Hamstring, Calf, and Quadricep Strains and Tears

Complete muscle/myotendinous ruptures are accompanied by an inability to use the knee, including an inability to walk [386,387]. Moderate to severe strains also produce considerable difficulty using the limb and bearing weight. Moderate to severe strains and tears generally cause swelling and ecchymosis. Development of hematoma in the area of the strain or rupture is common [386]. Mild strains may present with some difficulty with knee use and focal tenderness [386,387,388]. Often reproducible with forceful resistance on examination.

Iliotibial (IT) Band Syndrome

Patients with IT Band Syndrome have pain in the distal lateral thigh, which is typically worse with provocative activities, including running, cycling and other endurance sports. [87,103,389,390,391] Tenderness may be present along the lateral fascia from the lower thigh to the knee, particularly the lateral femoral condyle [116], and pain may be worse at 30° of flexion, especially when the hip is slightly extended and abducted, and then slowly adducts the affected hip. [117]

Knee Fracture

Patients with knee fractures are often unable to bear weight or walk [392], and bony deformity and crepitus may be present. Patients with stress fractures may be able to bear

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weight normally but usually have focal tenderness over the fibular head, patella, or tibia [392,393].

Knee Dislocation

Patellofemoral dislocations are the most common knee dislocation and may be congenital or trauma associated [394]. Patients with tibiofemoral knee dislocations tend to have a history of high energy-impact trauma [394] which do not spontaneously reduce are unable to bear weight or walk, have deformity, and may have signs of fractures. Tears of multiple ligaments are usually present and tenderness over sprained and/or torn ligaments is present. Effusions are usually present. The neuro/vascular structures and functions are the most critical initial evaluations.

Meniscal Tears

The extent of the meniscal tear usually determines the degree of physical examination abnormalities, which can range from marked findings to a normal examination. Patients with large, acute tears tend to have swelling, focal tenderness, difficulty walking, difficulty using the knee, locking, and giving out or buckling. Patients with mild, chronic degenerative tears that are symptomatic frequently have no effusion, but may have focal tenderness. Specific physical signs include joint line tenderness, McMurray's test (painful palpable click when moving knee from full flexion to 90°), Ege's test (audible and painful palpable click with squatting; feet turned outwards for medial meniscus and inwards for lateral), and Apley's test (pain on axial compression of the tibia with external rotation while patient prone and knee flexed [88,345,371,383,395-399]. The sensitivity of these tests is generally higher for medial than lateral meniscal tears [400,401], and it has been suggested that the tests should be combined for increased accuracy [402]. A systematic review found the sensitivity/specificity of joint line tenderness is 83%/83%, McMurray's is 61%/84%, and Thessaly 20deg is 75%/87% [403]. However, the overall quality of the studies was "generally poor."

Osteoarthrosis

Patients with osteoarthrosis usually have an antalgic or slow gait. Those with more severe disease commonly are slow to stand and initiate gait. Bony enlargement (osteophytes) develops [404]. Alignment may become abnormal. If medial joint disease is disproportionate, varus deformities typically develop. Other physical signs of osteoarthrosis include crepitus on range of motion. Tenderness is usually present but poorly localized, and effusions may or may not be present. Warmth and erythema are normally absent [404,405].

Patellar Dislocation

Patients with a dislocated patella cannot walk or bear weight on the knee [394]. Deformity with displacement of the patella is apparent. Testing for instability can include variants of a patellar apprehension test (putting a lateral force on the patella, causing a sensation that the patella may dislocate) [45,406]. The sensitivity and specificity of apprehension testing has been reported to be 100% and 88% specificity in a systematic review [407].

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Patellar Tendinopathy

The main finding of patellar tendinosis on physical examination is tenderness over the patellar tendon. The tendon is often affected at the junction with the patella, but the quadriceps insertion on the patella may also be affected. This condition is often seen in athletes and others with high explosive loading of the tendon ("jumper's knee") [408,409,410,411]. Unless the patellar tendon is ruptured, other associated anatomic abnormalities are infrequent.

Patellar Tendon Tears

Patellar tendon tears are relatively uncommon and present with an inability to walk [412,413]. Deformity of the anterior knee, with clinical findings of a ruptured patellar tendon, is present. Tenderness is also present, and there is usually some proximal patellar retraction proximally, also known as patella alta.

Patellofemoral Syndrome

Patients with patellofemoral syndrome have anterior knee pain, usually with a normal gait [414,415]. Patellar alignment may be normal, but is often lateral. Some measure the Q-angle), formed by a line drawn from the anterior superior iliac spine through the center of the patella and a line drawn from the center of the patella to the center of the tibial tubercle, is too large, although the clinical applicability of this angle appears weak [416-418]. Crepitus on range of motion (ROM) of the patella and with squatting or stair climbing is common. Pain with patellofemoral compression during ROM constitutes a positive grind test and may be helpful in the diagnosis of patellofemoral joint syndrome [419]. Tenderness along the edges of the patella has been reported to be 78% sensitive, 37% specific, and 58% accurate for the diagnosis of patellofemoral joint syndrome [344], although the positive likelihood ratio for this sign is under 2.5 [420].

MANAGEMENT APPROACH

Although comfort is often a patient's first concern, the treating physician must first evaluate for remediable conditions or red flags. Nonprescription analgesics may provide sufficient pain relief for most patients with acute or subacute knee pain. If treatment response is inadequate (i.e., if symptoms and activity limitations continue) or the physician judges the condition limitations to be more significant, prescribed pharmaceuticals or physical methods can be added. Co-morbid conditions, invasiveness, adverse effects, cost, and physician and patient preferences guide the choice of recommendations. Initial care, including comfort items, may consist of non-steroidal anti-inflammatory drugs (NSAIDs), acetaminophen, cryotherapy, heat, exercises, or education and advice on activities. Education about knee pain should begin at the first visit.

This guideline addresses the evidence for efficacy of many knee interventions. Interventions with quality evidence of proven efficacy are recommended in this guideline. Complication rates and safety profiles, if available, were considered in developing these guidelines.

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Interventions not supported by moderate- to high-quality studies are, if not otherwise noted, not recommended.

Patient Education Issues

Patients should be reassured that knee pain is common and provided with a return-to-work plan that is consistent with abilities. Knee arthroplasty is a major surgical procedure, but has a good prognosis. However, most knee arthrosis patients, particularly those without severe disease, do not require arthroplasty.

Osteonecrosis often requires surgery, although elimination of provocative exposures (e.g., alcohol) and use of bisphosphonates may substantially reduce the need for surgery.

Rest and disuse of body parts are not recommended for the management of knee conditions other than fractures, as they usually cause further disability and prolong treatment and recovery.

Patients should be provided realistic expectations for care, appropriate return to work (or limitations), and self-management instructions, as well as encouraged to maintain the highest reasonable level of function given the injury. Naturally, activity modifications may be helpful in reducing stresses on the knee.

Occupational Issues

Aside from either knee fracture patients in whom prolonged time away from work is often required, or stress fracture patients in whom significant restrictions to limit forceful activity and weight bearing may be recommended, patients should be encouraged to return to normal activity or work as soon as possible. Some situations might require modified duty. However, the more these activities are reduced, the greater the time generally required to rehabilitate the patient.

If knee pain is present, reduced activity may be necessary if the job physical requirements exceed the patient's capabilities.

A functional capacity evaluation (FCE) may help establish appropriate physical capacity for work. However, results should be interpreted with caution, as patients' efforts might be submaximal, e.g., due to pain or other factors. Testing is therefore preferably conducted by someone experienced in dealing with these types of patients and of sufficient duration to potentially record objectively observed tolerances. Nonphysical factors, return to work programs and participatory ergonomics should be addressed as needed. Patients should be empowered to accept responsibility for managing their recovery.

Adaptive Equipment/Assistive Devices and Other Physical Methods

Ambulatory assistive devices (e.g., canes and crutches) are often mandatory for severely affected patients until they can ambulate. (Some patients require coaching to not limp, as some continue to limp as a pain behavior.) However, physicians should balance use against risks of accelerated muscle weakness, particularly in mildly affected patients.

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Ice should be considered as a part of self-care at home, particularly in the acute and postoperative pain settings where they may be essential; and heat or ice in the chronic setting. They can provide temporary relief of symptoms, but can also reinforce pain and illness behaviors in persons with chronic pain. Many clinicians believe heat is not indicated in the acute phase of strains, sprains, and some other injuries, although acute low back pain has been demonstrated to be successfully treated with heat. Quality evidence for heat and ice in most knee disorders is lacking.

Ice, heat, ultrasound, and other similar modalities are rarely indicated for treatment of knee pain outside the self-care setting. However, they may be considered for certain cases of patellar tendinopathy and anserine bursitis.

Insoles and knee braces are modestly helpful for patients with osteoarthrosis who are compliant with their use and can be considered if other therapeutic options are limited.

There is no evidence to support prolonged and repetitive use of allied health therapies (massage, electrical therapies, manipulation, and acupuncture). Long-term and repetitive treatment, particularly if there is no documentation of functional improvement, is not indicated in managing patients with chronic pain, including knee pain from DJD.

Exercise Issues

Graded exercises to assist in achieving a return to normal function are indicated.

Gentle exercises are useful to regain normal range of motion (ROM) in the acute pain and post-operative settings. Aggressive stretching may be contraindicated if symptoms (e.g., pain and/or swelling) are substantially aggravated. It is also important for patients to understand that, while exercises after surgery may cause some discomfort, they should not cause significant increases in pain or new onset of increased swelling.

Aerobic and strengthening exercises appear most helpful for the rehabilitation of most chronic knee pain conditions (see specific guidance). Consultation with a physical therapist to determine the most appropriate exercises for the patient is recommended.

Medications

Initial management of most knee pain conditions should be with NSAIDs and acetaminophen. Suzetrigine may be a useful adjunctive option, particularly for postoperative management.

Opioids should be avoided for most patients. Newer management techniques (i.e., longer duration blocks, re-blocks, ice/cryotherapy, early ambulation, acetaminophen, NSAIDs and suzetrigine) have largely displaced need for long durations of opioids even among post-arthroplasty patients.

Glucocorticoid injections are indicated for treatment of bursitis, osteoarthrosis, chondromalacia patella, and as initial therapy in degenerative meniscal tears.

Other Issues

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Knee replacement surgery, osteotomy and other procedures are selectively recommended for symptoms of severe knee DJD that cannot be managed with other non-operative treatments (e.g., weight loss, medications, injections).

Surgery is indicated for knee meniscal tears that are either bucket handle or unresponsive to non-operative treatment.

Surgical repair is no longer routine for anterior cruciate ligament tears, although operative treatment is sometimes attempted particularly in younger patients with high sports demands and in demanding occupations (e.g., law enforcement; firefighters; frequent, forceful pivoting).

Intra-articular fragments, such as cartilage, in the knee joint may require arthroscopic exploration and removal.

The development of Individualized patient treatment and follow-up plans is recommended, which should incorporate the disorder's severity, co-morbidities, occupational demands, psychosocial factors, patient motivation, and need for encouragement. The ability to return to work should be considered when determining the frequency of follow-up. More frequent appointments are generally required for patients whose limitations have not been accommodated. The patient should be transitioned to work, or from modified work to full work, at the earliest date possible. Patients should be supported during that transition and counseled about the likelihood of increased symptoms while being reassured that pain does not equate to injury.

FOLLOW-UP VISITS

Patients with knee symptoms should have initial follow-ups approximately every 3 to 7 days, especially if they are unable to work, or are on modified duty. Additional factors include severity of the condition, and ability of the workplace to accommodate limitations. Considerations for the initial follow-up visits include: response to treatment, further education, advice to avoid static positions, medication use, activity modification, and other concerns. The practitioner can answer questions and make these sessions interactive so that the patient is fully involved in his or her recovery. If the patient has returned to work, these interactions may be done on site or by telephone to avoid interfering with modified- or full-work activities.

Individualized patient treatment and follow-up plans are best based on the severity of the condition, co-morbidities, occupational demands, psychosocial factors, and patient motivation and need for encouragement. The ability to return to work should be considered when determining the frequency of follow-up. More frequent appointments are generally required for patients whose limitations have not been accommodated. The patient should be transitioned to work, or from modified work to full work, at the earliest date possible, and should be supported during that transition and counseled about the likelihood of increased symptoms while being reassured that pain does not equate to injury.

MONITORING/AUDITING CRITERIA

The clinician is recommended to assure:

1. Patients with knee osteoarthritis are treated with walking exercises. Target >90%

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2. Patients with knee osteoarthritis requiring analgesia are treated with NSAIDs. Target >90%
3. Knee arthroplasty patients are provided perioperative venous thrombosis prophylaxis. Target 100%
4. Knee surgery patients are ambulated the day of surgery. Target >90%

KNEE PAIN AND OSTEOARTHROSIS

DIAGNOSTIC RECOMMENDATIONS

ANTIBODIES

There are numerous antibodies that are markers for specific rheumatic diseases (e.g., rheumatoid factor, anti-nuclear antibodies, anti-Sm, anti-Ro, anti-La for rheumatoid arthritis, systemic lupus erythematosus, Sjogren's, mixed connective tissue disorder, etc.). Patients with rheumatic disorders are at increased risk for degenerative joint disease of the knee [223,421-427].

ANTIBODIES FOR DIAGNOSING KNEE PAIN WITH SUSPICION OF CHRONIC OR RECURRENT RHEUMATOLOGICAL DISORDER

Recommended

Antibody levels are recommended to evaluate and diagnose patients with knee pain who have reasonable suspicion of rheumatological disorder. Antibody levels are strongly recommended to confirm a specific disorder with a high clinical suspicion (e.g., rheumatoid arthritis). However, ordering of a large, diverse array of antibody levels without targeting a few specific disorders is not recommended.

Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Low

Indications

Knee pain with suspicion of rheumatological disorder.

Rationale

Antibody tests have been used to evaluate knee pain with suspicion of a rheumatological disorder (Gao et al., 2012, Sun et al., 2014, Yang et al., 2016, Dai et al., 2019). Elevated antibody levels are useful for confirmation of clinical impressions of rheumatic diseases (Mohan et al., 2015, Sun et al., 2014, Motta et al., 2023, Dai et al., 2019, Yang et al., 2016, Lo et al., 2020, Payet et al., 2014, Verheul et al., 2018, Dollah et al., 2011, Hermosillo-Villafranca et al., 2021, Tenstad et al., 2020, Longobardi et al., 2023). However, routine use of these tests for knee pain, especially as wide-ranging nonfocused test batteries, are likely to result in inaccurate diagnoses due to false positives and low pre-test probabilities. Clinicians should also be aware that false-negative results occur. Measurement of antibody levels is recommended for focused testing of a limited number of diagnostic considerations for which there is clinical suspicion. Repeat measurements of a discrete antibody level (e.g., rheumatoid factor) early in the course of disease and given ongoing reasonable suspicion is

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also recommended as results may become positive with time after disease onset. Measuring antibody levels is minimally invasive, unlikely to have substantial adverse effects and low to moderately costly, depending on the specific test ordered.

Evidence

A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: antibodies, antibody testing, serology; patellofemoral pain syndrome, knee osteoarthrosis, knee pain, rheumatic diseases, meniscus, meniscal tear, acute knee pain, chronic knee pain; diagnosis, diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 8,121 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 8,121 articles, 118 in CINAHL, 1,472 in Cochrane Library, 737 in Google Scholar, and 0 from other sources†. We considered for inclusion 3 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 3 articles considered for inclusion, 3 diagnostic studies and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

ARTHROGRAPHY

Diagnostic arthrography has been largely replaced by MRI.

ARTHROSCOPY

Arthroscopy of the knee has been increasingly utilized for treatment of knee disorders [1,396,428-455]. It has become the gold standard for measuring the utility of the clinical examination, other diagnostic tests, as well as the comparative standard for other treatments [456]. Disorders commonly treated arthroscopically include meniscal tears, cruciate tears, and chondral fractures [441,457-462]. However, there are few high-quality studies

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from which to determine indications for either diagnostic or therapeutic arthroscopic knee procedures, particularly as it is the gold standard.

KNEE ARTHROSCOPY FOR DIAGNOSING AND TREATING KNEE PAIN

Sometimes Recommended

Arthroscopy is selectively recommended to evaluate and diagnose patients with knee pain if there is suspicion of a clinically significant meniscal tear, cruciate tear, intraarticular body, or other subacute or chronic mechanical symptoms. It is otherwise not recommended for treatment of knee osteoarthrosis.

Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Low

Indications

Knee pain with suspicion of loose body, meniscal tear, osteochondritis dissecans, septic arthritis, periprosthetic infection, or other subacute or chronic mechanical symptoms treatable by arthroscopy. See also indications for specific disorders (e.g., meniscectomy, ACL reconstruction).

Rationale

Knee arthroscopy has been used to evaluate and treat acute, subacute, and chronic osteoarthrosis without mechanical symptoms and other remediable mechanical defects (Katz et al., 2014). Arthroscopy of the knee is widely utilized for treatment of several knee disorders, especially meniscal tears. Quality studies of the efficacy of arthroscopy are naturally impaired by its status as the gold standard and/or comparator for other diagnostic tests (Alardi et al., 2024, Hashemi et al., 2020, Khorsheed et al., 2024, Navali, 2013, Patil et al., 2024). Complications more commonly occur among those with more serious injuries and include nerve retraction, neuropraxias, infection, and complex regional pain syndrome (Sampson, 2001, Yacub et al., 2009, Wang et al., 2009, Judd et al., 2006, Clarke et al., 2003, Griffin et al., 1999, Narvani et al., 2003, Byrd et al., 1998, Kim et al., 1998, Funke et al., 1996). Adverse effects are generally minimal when small-bore arthroscopes are used.

Osteoarthrosis was previously thought to be treatable by arthroscopy (Ike, 1993). However, arthroscopy is currently shown to be unhelpful and/or does not result in meaningful improvements in a quality studies, a Cochrane review and other systematic reviews (O'Connor et al., 2022, Palmer et al., 2015, Brignardello-Petersen et al., 2017, Katz et al., 2014) in the absence of significant remediable mechanical symptoms suggesting a clinically significant meniscal tear or intraarticular body (Moseley et al., 2002).

Arthroscopy is invasive and expensive, but it is selectively recommended, particularly those with remediable mechanical defects such as meniscal tears, cruciate tears, intraarticular bodies, and other meaningful mechanical symptoms.

Evidence

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A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: knee arthroscopy, arthroscopy, patellofemoral pain syndrome, knee osteoarthrosis, knee pain, rheumatic diseases, meniscus, meniscal tear, acute knee pain, chronic knee pain; diagnosis, diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 3032 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 3032 articles, 481 in CINAHL, 15 in Cochrane Library, 12600 in Google Scholar, and 0 from other sources.† We considered for inclusion 0 from PubMed, 4 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 4 articles considered for inclusion, 3 diagnostic studies and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

BONE SCANS

Bone scans involve intravenous administration of a radioactive tracer medication that is preferentially concentrated in areas of metabolic activity in bone [463,464]. The radioactivity is then detected by a large sensor and converted into images of the skeleton. There are many causes of abnormal radioactive uptake, including metastases, infection, inflammatory arthropathies, fracture or other significant bone trauma. Thus, bone scans are not highly specific. Bone scans have been used for the diagnosis of early osteonecrosis, which is often not apparent on x-ray [465,466,467,468].

BONE SCANS FOR EVALUATING KNEE PAIN

Sometimes Recommended

Bone scanning is selectively recommended in patients with acute, subacute, or chronic knee pain to assist in diagnosing osteonecrosis, neoplasms, or other conditions with increased polyostotic bone metabolism, particularly if more than one joint is to be evaluated.

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Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Patients with acute, subacute, or chronic knee pain thought to potentially be related to osteonecrosis, neoplasms, or other conditions with increased polyostotic bone metabolism, particularly if more than one joint is to be evaluated.

Rationale

Bone scanning may be a helpful diagnostic test to evaluate suspected metastases, primary bone tumors, infected bone (osteomyelitis), and trauma (e.g., occult fractures although computed tomography is the first test for that indication). It may be helpful in those with suspected early AVN without x-ray changes. There is no indication for bone scanning in cases where the diagnosis is felt to be secure, as bone scanning does not alter management. Bone scanning is minimally invasive, has minimal potential for adverse effects (essentially equivalent to a blood test), but it is costly. Therefore, it is selectively recommended.

Evidence

A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: bone scan OR DEXA; patellofemoral pain syndrome, knee osteoarthrosis, knee pain, meniscus, meniscal tear, acute knee pain, chronic knee pain; diagnosis, diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 821 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 821 articles, 72 in CINAHL, 71 in Cochrane Library, 3,210 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 1 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 diagnostic study and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of

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100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

COMPUTED TOMOGRAPHY (CT)

Computed tomography is a useful imaging procedure for bony anatomy, whereas MRI is superior for soft tissue abnormalities [469,470]. CT may be useful for certain knee joint abnormalities, including occult and complex fractures, in which advanced imaging of the bones is required. CT may be helpful for the evaluation of AVN [471-477]. CT may also be useful for evaluation of the spine in patients with contraindications for MRI, including implanted metallic-ferrous device [470]. CT with 3D reconstruction is helpful for complex fracture evaluation.

COMPUTED TOMOGRAPHY (CT) FOR EVALUATING KNEE PAIN

Recommended

Computed tomography (CT) is recommended for evaluating patients with potential occult fractures, osteonecrosis, osteomyelitis, tumors, and periprosthetic osteolysis after knee arthroplasty, as well as for patients who need advanced imaging but have contraindications for MRI.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Patients with potential occult fractures, osteonecrosis, osteomyelitis, tumors, and periprosthetic osteolysis after knee arthroplasty, as well as for those who need advanced imaging but have contraindications for MRI.

Rationale

CT has been used to evaluate acute, subacute, and chronic knee pain (Drew et al., 2016). Computed tomography is considered superior to MRI for imaging of most knee abnormalities where advanced imaging of calcified structures is required, particularly including occult fractures. CT has been used to evaluate periprosthetic osteolysis (Reish et al., 2006). CT is also helpful for evaluating patients with potential osteonecrosis (Iqbal et al., 2022, Gayana et al., 2016, Bharadwaj et al., 2025, Wang et al., 2025, Park et al., 2019, Han et al., 2017, Yoon et al., 2020), osteomyelitis, and tumors. CT is an important imaging technique for those who need advanced imaging, but have contraindications for MRI. A contrast CT study is minimally invasive, has few adverse effects, but is costly. It is recommended for select use. CT is recommended for evaluating patients with potential occult fractures, osteonecrosis, osteomyelitis, tumors, and periprosthetic osteolysis after knee arthroplasty, as well as for patients who need advanced imaging but have contraindications for MRI.

Evidence

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A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: computed tomography, patellofemoral pain syndrome, knee osteoarthrosis, knee pain, rheumatic diseases, meniscus, meniscal tear, acute knee pain, chronic knee pain; diagnosis, diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 1321 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 1321 articles, 87 in CINAHL, 26 in Cochrane Library, 16000 in Google Scholar, and 4 from other sources†. We considered for inclusion 2 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 3 from other sources. Of the 7 articles considered for inclusion, 6 diagnostic studies and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

CYTOKINES

See the Chronic Pain guideline.

ELECTROMYOGRAPHY (INCLUDING NERVE CONDUCTION STUDIES)

See the Low Back Disorders guideline for discussion regarding the use of electrodiagnostic studies for evaluation of back-related disorders that may present as knee pain. Electrodiagnostic studies have also been used to confirm diagnostic impressions of other peripheral nerve entrapments, including of the lateral cutaneous nerve of the thigh (meralgia paresthetica) [478-490].

ELECTROMYOGRAPHY FOR DIAGNOSING PERIPHERAL NERVE ABNORMALITIES

Sometimes Recommended

Electrodiagnostic studies are recommended to assist in the diagnosis of subacute or chronic peripheral nerve abnormalities including peroneal, saphenous, femoral, and tibial.

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Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Subacute or chronic paresthesias with or without pain, particularly with an unclear diagnosis. Symptoms of paresthesias should be present for at least 3 weeks, otherwise, the testing documents a pre-existing condition.

Rationale

Electrodiagnostic studies may assist in confirming peripheral nerve entrapments. These studies are minimally invasive, have minimal potential for adverse effects (essentially equivalent to a blood test), and are moderately costly. Thus, they are selectively indicated for diagnostic testing.

Evidence

A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: electromyography, electrodiagnosis, EMG, nerve compression syndromes, osteoarthritis, knee osteoarthrosis, knee pain, acute knee pain, chronic knee pain; diagnosis, diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 1,454 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 1,454 articles, 24 in CINAHL, 17 in Cochrane Library, 17,500 in Google Scholar, and 0 from other sources†. We considered for inclusion 1 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 diagnostic study and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

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FUNCTIONAL CAPACITY EVALUATIONS

See the Chronic Pain guideline.

INFLAMMATORY MARKERS

There are many markers of inflammation that may be measured serologically. These include C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), ferritin, and a total protein-albumin gap [491,492,493,494].

NONSPECIFIC INFLAMMATORY MARKERS FOR EVALUATING KNEE PAIN

Recommended

Erythrocyte sedimentation rate and other inflammatory markers are recommended to evaluate for inflammatory disorders or prosthetic sepsis when there is a reasonable suspicion of an inflammatory disorder in patients with subacute or chronic knee pain. However, ordering a large, diverse array of inflammatory markers without targeting specific disorders for which there is clinical suspicion is not recommended.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Knee pain with suspicion of inflammatory disorder, including infection.

Rationale

Erythrocyte sedimentation rate is the most commonly used systemic marker for nonspecific inflammation. The ESR is elevated in numerous inflammatory conditions, including rheumatological disorders, as well as with infectious diseases. C-reactive protein is a marker of systemic inflammation that has been reported to be associated with an increased risk of coronary artery disease. However, it is also a nonspecific inflammatory marker. Other nonspecific markers of inflammation include an elevated ferritin and protein-albumin gap. CRP and ESR measurements are minimally invasive, have low risk of adverse effects, and are relatively inexpensive. They are recommended as a reasonable component of the evaluation when there is suspicion of a systemic inflammatory condition, including a rheumatological evaluation; however, specific tests including antibodies that have better sensitivity and particularly specificity are generally preferrable for diagnostic testing (see the recommendation for Antibodies for Diagnosing Knee Pain with Suspicion of Chronic or Recurrent Rheumatological Disorder).

Evidence

A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: C-reactive protein, non-specific inflammatory markers, plasma viscosity, erythrocyte sedimentation rate, patellofemoral pain syndrome, knee osteoarthrosis, knee pain, rheumatic diseases, meniscus, meniscal tear, acute knee pain, chronic knee pain; diagnosis,

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diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 0 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 0 articles, 0 in CINAHL, 0 in Cochrane Library, 12,100 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

LOCAL ANESTHETIC INJECTIONS AND EPIDURALS

Local anesthetic injections are sometimes used for diagnostic confirmation of knee conditions (see Injections). These injections are also sometimes used to differentiate pain from a distant site, such as the hip or spine. Diagnostic injections include intraarticular injections (knee, hip, or sacroiliac), ilioinguinal, genitofemoral, and saphenous nerve blocks, and lumbar epidurals [495,496,497,498].

LOCAL ANESTHETIC INJECTIONS TO DIAGNOSE SUBACUTE OR CHRONIC KNEE PAIN

Sometimes Recommended

Local anesthetic injections are selectively recommended to assist in the diagnosis of subacute or chronic knee pain.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Subacute or chronic knee pain from an unclear source; immediate and delayed results of injection(s) should be recorded.

Rationale

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Local anesthetic injections may be helpful for confirming diagnostic impressions (e.g., per anserine bursitis), although there are no quality studies evaluating the use of injections for these purposes. Intraarticular knee injections are often performed with anesthetic agents and glucocorticosteroids, which are addressed separately with specific guidance and indications. Diagnostic injections are minimally invasive, have minimal potential for adverse effects, and are moderately costly. They are selectively recommended to diagnose and identify potential interventions.

Evidence

A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: local anesthetics, local anesthetic injections, genicular nerve block, patellofemoral pain syndrome, knee pain, knee osteoarthrosis, rheumatic diseases, meniscus, meniscal tear, acute knee pain, chronic knee pain; diagnosis, diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 743 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 743 articles, 11 in CINAHL, 5 in Cochrane Library, 808 in Google Scholar, and 0 from other sources. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources.† Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

MAGNETIC RESONANCE IMAGING (MRI)

Magnetic resonance imaging (MRI) has been widely used for diagnostic purposes in patients with knee pain, particularly for evaluating the menisci, cruciate ligaments and chondral injuries [395,428,429,431-455,499-501]. MRI is considered the gold standard for evaluating AVN [502-510].

Magnetic resonance imaging with arthrography (MR arthrography) has been performed to evaluate meniscal and chondral lesions [511,512], for example following chondrocyte and meniscus implants [512,513].

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MAGNETIC RESONANCE IMAGING (MRI) FOR EVALUATION OF KNEE JOINT PATHOLOGY

Sometimes Recommended

MRI is recommended for evaluation of patients with suspected cruciate ligament tears and hamstring and other muscle tears, especially to ascertain the degree of tear and whether surgery is needed. MRI is recommended for select patients with subacute or chronic knee symptoms that are mechanically disruptive and/or when similar soft-tissue pathology is a concern. MRI is not generally indicated for patients with acute knee pain. MRI is also not generally indicated for routine evaluation of knee meniscal tears, especially for patients who are expected to undergo arthroscopy regardless of the MRI findings.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Suspected cruciate ligament tears and hamstring and other muscle tears, especially to ascertain the degree of tear and whether surgery is needed; subacute or chronic knee symptoms which are mechanically disruptive and/or similar soft tissue pathology is a concern.

Rationale

MRI has been used to evaluate knee joint pathology including diagnosing meniscal tears, cruciate ligament tears, hamstring and other muscular tears, and for select patients with post-arthroplasty chronic pain or periarticular masses (Koo et al., 2020).

MRI has been evaluated in many quality studies. This is analyzed by tissue/structure.

Cruciate ligament tears. Up to 2% of asymptomatic adults are estimated to have an undiagnosed ACL tear (Culvenor et al., 2019). Many reports support a moderate ability of MRI to detect cruciate tears (Nam et al., 2014, Kim et al., 2021, Felli et al., 2016, Shantanu et al., 2021, Krakowski et al., 2019, Babalola et al., 2021, Van Dyck et al., 2011, Barbier et al., 2013, Lee et al., 2013, Awan, 2021, Awan et al., 2022, Shrestha et al., 2023, Richards et al., 2016, Khandelwal et al., 2018, Zhang et al., 2025, Cheng et al., 2024, Wang et al., 2021, Tran et al., 2022, Syal et al., 2015, Cook et al., 2014)(Liu et al., 1995, Lee et al., 1988, Glashow et al., 1989, Mink et al., 1988, Munk et al., 1998, Weinstabl et al., 1997). Precision of the location of the tear determined by MRI was noted to be problematic (Kantrowitz et al., 2025). A meta-analysis found a sensitivity of 87% and specificity of 93%, although it noted a high risk of bias in the published literature (Phelan et al., 2016). Deep learning models reportedly assist in detection accuracy (Behr et al., 2025, Wang, 2024, Tran et al., 2022, Vosshenrich et al., 2025). One report noted a three-dimensional MRI with a 3T magnet is reportedly superior (Shakoor D, 2019). However, expert clinical examinations are reportedly superior to MRI for detection of ACL tears (Krakowski et al., 2019, Jah et al., 2005), especially the Lachman test (Décary et al., 2017). Regardless, the decision to operate is often apparent with a clinical examination. Thus, MRI is selectively recommended for the evaluation of cruciate tears where there is diagnostic uncertainty and there is no clear

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decision to proceed to surgery in someone who is a surgical candidate instead of a rehabilitative candidate.

Meniscal tears. The prevalence of meniscal tears in asymptomatic adults on MRI imaging rises sharply with age from ~20% among those in their 30s to 63% among those in their seventies (Englund et al., 2008); this can produce significant challenges with interpreting MRI imaging for patients with symptoms. Many reports support a moderate ability of MRI to detect meniscal tears (Rinonapoli et al., 2011, Nam et al., 2014, Arner et al., 2017, Kim et al., 2021, Felli et al., 2016, Shantanu et al., 2021, Sanchez-Munoz et al., 2023, Babalola et al., 2021, Dufka et al., 2016, Mostafa et al., 2019, Antinolfi et al., 2017, Ahn et al., 2016, Syal et al., 2015, Cook et al., 2014)(Liu et al., 1995, Lee et al., 1988, Glashow et al., 1989, Mink et al., 1988, Munk et al., 1998, Weinstabl et al., 1997). One comparative study found US was superior to MRI (Cook et al., 2014), although another found MRI superior (Ahmadi et al., 2024, Ravichandra et al., 2014). A meta-analysis calculated sensitivity of 89% and specificity of 88%, although the authors felt there was a high risk of bias present in the studies (Phelan et al., 2016). False-negative MRI interpretations are particularly likely in the lateral meniscus (Krych et al., 2018) and posterior horn meniscal tears (Quinn et al., 1991). Magnet strength (1.5T vs. 3.0T) did not materially affect detection (Van Dyck et al., 2013). However, an expert clinical examination has been shown in many quality studies to be superior to MRI for meniscal tears (Hashemi et al., 2020, Khorsheed et al., 2024, Navali, 2013, Shantanu et al., 2021, Krakowski et al., 2019, Antinolfi et al., 2017, Dufka et al., 2016, Jah et al., 2005). Thus, MRI is selectively recommended for the evaluation of cruciate tears where there is diagnostic uncertainty and there is no clear decision to proceed to surgery.

Osteoarthrosis. The prevalence of OA increases markedly with age. MRI has been used to stage osteoarthrosis (Guermazi et al., 2009) and to detect findings of OA when x-rays are negative (Guermazi et al., 2012), although both x-ray (Newman et al., 2022) and CT reportedly perform better (Roemer et al., 2023, Segal et al., 2015) and there is no quality evidence that these practices affect either prognosis or treatment. MRI can detect osteophytes (Chan et al., 1991) and is better than x-ray for identifying cartilage loss and subchondral cysts, but it is relatively poor at detecting early subchondral sclerosis (Chan et al., 1991, McAlindon et al., 1991). There is quality evidence that meniscal tears found on MRI of patients with osteoarthrosis are not correlated with pain or functional status (Bhattacharyya et al., 2003). MRI is not recommended for evaluation of most cases of osteoarthrosis, unless there is a clear mechanical issue present that may potentially require surgical repair.

Osteonecrosis. MRI has not been evaluated in quality studies for knee osteonecrosis, although there are quality studies in the femoral head which show a high degree of diagnostic accuracy (see Hip and Groin Disorders) (Kathale et al., 2020, Wang et al., 2021) There is low-quality evidence that MRI may be less sensitive for detection of subchondral fractures than helical CT or plain x-rays in patients with osteonecrosis (Stevens et al., 2003). MRI is recommended for evaluation of potential knee osteonecrosis cases including for staging.

Patellofemoral pain, instability: MRI has been used to evaluate patellofemoral syndrome (Pacini et al., 2023, Baz et al., 2019, Dautry et al., 2014, e Souza et al., 2013, Fahmy et al.,

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2016, Mattila et al., 2012, Samim et al., 2014, Malmgaard-Clausen et al., 2021). A systematic review found MRI had a good ability to detect cartilage defects (Harris et al., 2012). One study suggested there is no association between MRI findings and patellofemoral pain syndrome (van der Heijden et al., 2016). Another reported increased thickness of the patellar tendon (Malmgaard-Clausen et al., 2021). Regardless, which findings are more characteristic of the condition and whether any findings found that affect the prognosis or treatment is unclear. Thus, there is no recommendation for MRI for evaluation of patellofemoral pain.

Hamstring strains and other muscle tears MRI has been evaluated in studies of hamstring and other muscle tears (Ekstrand et al., 2012, Hamilton et al., 2014, Wangensteen et al., 2017) and many publications support a predictive value of the severity of findings on MRI regarding return to sport (Tears et al., 2022, Crema et al., 2016, Day et al., 2024, Fenn et al., 2024, Hamilton et al., 2014, Reiman et al., 2013, Pezzotta et al., 2017). Thus, MRI is recommended for select cases where there is uncertainty regarding the degree of tear and whether surgery is needed.

Evidence

A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: magnetic resonance imaging, MRI; meniscus, osteoarthritis, knee pain, chronic knee pain, meniscal tear, cruciate ligament tears, hamstring tears, muscular tears; diagnosis, diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 7942 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 7942 articles, 1019 in CINAHL, 43 in Cochrane Library, 16900 in Google Scholar, and 2 from other sources†. We considered for inclusion 14 from PubMed, 0 from CINAHL, 1 from Cochrane Library, 20 from Google Scholar, and 2 from other sources. Of the 39 articles considered for inclusion, 36 diagnostic studies and 3 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

MAGNETIC RESONANCE (MR) ARTHROGRAM FOR MENISCAL/CARTILAGE IMAGING OR POST-CHONDROCYTE IMPLANTATION

Sometimes Recommended

Magnetic resonance (MR) arthrograms are recommended for select patients who require advanced imaging of the menisci and articular cartilage or following procedures such as chondrocyte implantation.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Patients with negative or equivocal MRI imaging with ongoing suspicion of clinically significant intraarticular pathology such as meniscal tears or articular cartilage defects or following selected procedures, such as chondrocyte implantation.

Rationale

MR arthrograms have been used to evaluate patients needing advanced meniscal and cartilage imaging and following chondrocyte implantation (Harris et al., 2012, Samim et al., 2014, Smith et al., 2015, Xará-Leite et al., 2023, Moteshakereh et al., 2024). MR arthrograms have not been evaluated in quality studies, but appear helpful in evaluating patients with ongoing intraarticular mechanical symptoms despite negative or inconclusive MRIs. These studies are also likely to be helpful for those with certain postoperative indications, including after chondrocyte implantation. MR arthrography is minimally invasive, has no adverse effects, although there may be issues related to claustrophobia or complications of concomitantly administered medications, but it is costly. However, it is likely the best imaging procedure available for certain select patients.

Evidence

A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: magnetic resonance arthrograms, MR arthrograms, patellofemoral pain syndrome, knee osteoarthrosis, knee pain, rheumatic diseases, meniscus, meniscal tear, acute knee pain, chronic knee pain; diagnosis, diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 12 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 11 articles, 185 in CINAHL, 182 in Cochrane Library, 1,440 in Google Scholar, and 0 from other sources†. We considered for inclusion 3 from PubMed, 3 from CINAHL, 1 from Cochrane Library, 2 from Google Scholar, and 0 from other sources. Of the 9 articles considered for inclusion, 3 diagnostic studies and 6 systematic reviews met the inclusion criteria.

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Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

X-RAYS (RADIOGRAPHS)

X-ray is the initial test for evaluation of most cases of knee pain [223,340,430,514-519]. X-rays are considered the initial test of choice for evaluating patients with suspected knee osteoarthrosis. Two or three supine views are generally performed. In cases where osteoarthrosis is suspected, standing AP views should be included [520]. There are no quality studies of x-ray in the evaluation of knee pain. It should be noted that the threshold for x-ray of the lumbosacral spine and/or hip joint should be low, particularly if the findings on knee x-ray are either normal or do not readily explain the degree of clinical findings. Stress radiography (x-ray taken while a stress is applied to the joint and used to demonstrate instability) has been described for evaluation of ACL tears, but is not usually necessary to establish a diagnosis [379]. In the case of osteonecrosis, plain x-ray results may assist in ascertaining the stage of disease. Early x-rays are usually normal or have less distinct trabecular patterns, but as the disease progresses, x-rays begin to show osteoporotic areas progressing to sclerotic areas and flattening and bony collapse [521]. X-rays are also used to evaluate post-arthroplasty knees.

RADIOGRAPHS (X-RAYS) FOR EVALUATING KNEE PAIN

Recommended

X-rays are recommended for evaluating acute, subacute, or chronic knee pain.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Evaluation of acute, subacute, or chronic knee pain. However, as abnormalities are common and become ubiquitous with age, proper interpretation is essential.

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Frequency/Dose/Duration

Obtaining x-rays once is generally sufficient. For patients with chronic or progressive knee pain, it may be reasonable to obtain a second set of x-rays, months to years after the baseline x-rays to re-evaluate the patient's condition, particularly if symptoms change.

Rationale

Radiographs (x-rays) have been used to evaluate acute, subacute, and chronic knee pain (Shohat et al., 2022). X-ray is helpful in evaluating most knee pain, both to diagnose and to assist with narrowing the differential diagnosis. It is the initial diagnostic test to evaluate acute injuries for fractures. A clinical algorithm was constructed to evaluate the need for x-ray to rule out fracture, and the presence of at least one sign of fracture was deemed to be highly sensitive for fracture (Bauer et al., 1995). There are multiple studies suggesting functional integrity of the ACL can be assessed with stress radiographs (Schwartz et al., 2024, James et al., 2014, Lodewijks et al., 2019, Wang et al., 2021, Noh et al., 2019, Ryu et al., 2021, Beldame et al., 2011, Holliday et al., 2021, Kim et al., 2020, Lee et al., 2011, Lee et al., 2019, Mabrouk et al., 2023, Mae et al., 2018, McDonald et al., 2016, Panisset et al., 2012).

There are no quality studies of the use of x-ray to evaluate knee pain. There is one low-quality study suggesting x-ray has higher sensitivity than MRI for detection of subchondral fractures in patients with osteonecrosis (Stevens et al., 2003)(Crim et al., 2021) and x-rays are also helpful for identifying sclerotic findings of osteonecrosis. X-ray has long been used to stage osteoarthrosis (Altman, 1987, Buckland-Wright, 1997, Guermazi et al., 2009, Ahlback, 1968, Buckland-Wright et al., 1995, Kellgren et al., 1957, Bellamy et al., 1999, Thomas et al., 1975) and evaluate for post-arthroplasty osteolysis (Marx et al., 2005). Radiographs are noninvasive, low to moderately costly, and have little risk of adverse effects. Therefore, they are recommended for evaluation of acute, subacute, and chronic knee pain.

Evidence

A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: X-rays OR radiography, patellofemoral pain syndrome, knee osteoarthrosis, knee pain, rheumatic diseases, meniscus, meniscal tear, acute knee pain, chronic knee pain; diagnosis, diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 10,820 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 10,820 articles, 514 in CINAHL, 675 in Cochrane Library, 3,080 in Google Scholar, and 0 from other sources†. We considered for inclusion 6 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 4 from Google Scholar, and 0 from other sources. Of the 10 articles considered for inclusion, 8 diagnostic studies and 2 systematic reviews met the inclusion criteria.

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Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

SALINE LOAD TEST

The saline load test has been used when there is a knee laceration to determine whether there has been penetration of the joint capsule [522,523,524] with and without methylene blue [525]. The test involves injection of saline into the joint to ascertain whether the solution flows thought the joint capsule and out of the trauma site [526].

SALINE LOAD TEST FOR KNEE LACERATIONS

Sometimes Recommended

A saline load test is recommended for select patients with knee lacerations that may have penetrated the joint.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Lacerations in the knee region that may have penetrated the knee joint but have not clearly done so.

Frequency/Dose/Duration

At least 150 to 200 mL of saline injected with an 18G needle. Volume required varies based on size of potential laceration (more saline required for smaller lacerations) and may differ based on location of laceration. The lateral suprapatellar instillation site has been utilized (Keese et al., 2007). Superomedial and inferomedial locations have been compared; more volume is required for the superomedial location (mean 95.2 vs. 64.0 mL) (Nord et al., 2009).

Rationale

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There are no quality studies of the saline load test in the evaluation of joint capsule penetration. A study of 30 arthroscopy patients suggested that more than 194 mL was required for the saline load test to be at least 95% sensitive (Keese et al., 2007). Another study of knee arthroscopy patients found at least 155mL of saline must be injected to detect 95% of 1-cm inferolateral arthrotomies (Nord et al., 2009). This procedure is minimally invasive, has minimal potential for adverse effects, is relatively inexpensive, and is recommended for select patients.

Evidence

A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: saline load test, patellofemoral pain syndrome, knee osteoarthrosis, knee pain, rheumatic diseases, meniscus, meniscal tear, acute knee pain, chronic knee pain; diagnosis, diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 32 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 32 articles, 1,451 in CINAHL, 54 in Cochrane Library, 7,490 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 2 from other sources. Of the 3 articles considered for inclusion, 1 diagnostic studies and 2 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

ULTRASOUND

Many of the usual causes of knee pain (e.g., ligament, chondral injury, menisci) are better imaged with modalities other than ultrasound. Diagnostic ultrasound has been used for evaluating the patellar ligament, including for “jumper’s knee” and partial ruptures [411,527-533], effusions [534], dysplasia [535,536], labral tears [537], and occult factures [538]. Ultrasound for cruciate ligament tears has been described as technically difficult [348]. Ultrasound has also

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been used to guide injections in deep body structures, although the knee joint is relatively accessible. The diagnostic accuracy of ultrasound for patellar partial ligament ruptures has been reported as 100% in a modest sized case series [527].

ULTRASOUND FOR EVALUATING KNEE JOINT PATHOLOGY

Sometimes Recommended

Ultrasound is selectively recommended for evaluating patients with patellar tendinopathy, ACL tears, meniscal tears, pes anserine bursitis, hamstring strains, quadriceps strains, post-arthroplasty chronic pain, or when peri-articular masses are suspected.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Ultrasounds have been used to evaluate patellar tendinopathy, pes anserine bursitis, hamstring strains, quadriceps strains, or postarthroplasty chronic pain when periarticular masses are suspected (Matthews et al., 2018, Fidel et al., 2024). There are some quality studies of ultrasound. However, many studies did not use the gold standard of arthroscopy and were necessarily excluded (Singh et al., 2021, Mohammed et al., 2025, Gao et al., 2023, Draghi et al., 2015, Konar et al., 2025, Wang et al., 2009, Mautner et al., 2019, Grzelak et al., 2015, Lee et al., 2020, Kumar et al., 2018, Raj, 2024, Mir et al., 2021, Awan et al., 2024, Ahmadi et al., 2022).

Irrespective of guidance in support of selective use of ultrasound below, there is no additional need for ultrasound if an MRI is going to be ordered; therefore, ultrasound is not recommended under those circumstances.

Bursitis
One study found ability to detect pes anserine bursitis (Toktas et al., 2015). A systematic review reported that ultrasound was superior to physical examination for detection of effusion (Meyer et al., 2022). Ultrasound is recommended for evaluation of bursitis.

Cruciate ligament tears
Ultrasound has been used to evaluate cruciate ligament tears and found to be helpful (Breukers et al., 2019, Ptasznik et al., 1995) (Lee et al., 2019, Breukers et al., 2019, Raj, 2024, Wasilczyk, 2024), which was also found in systematic reviews with meta-analysis (Fucaloro et al., 2025, Schreiner et al., 2025). Regardless, the decision to operate is often apparent with a clinical examination. Therefore, ultrasound is selectively recommended for the evaluation of cruciate tears where there is diagnostic uncertainty and there is no clear decision to proceed to surgery in someone who is a surgical candidate instead of a rehabilitative candidate.

Meniscal tears
Studies have found discriminant ability of US to detect meniscal tears (Wareluk et al., 2012, Akatsu et al., 2015, Salroo et al., 2025, Alizadeh et al., 2013, Slade et al., 2008, Mureşan et

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al., 2017, Ravichandra et al., 2014) (Raj, 2024, Salroo et al., 2025, Timotijevic et al., 2014, Dai et al., 2015, Asai et al., 2025, Uusimaa et al., 2024, Akatsu et al., 2015). One comparative trial found US superior to MRI (Cook et al., 2014), although others found MRI better (Ahmadi et al., 2024, Ravichandra et al., 2014). Thus, US is selectively recommended for the evaluation of cruciate tears where there is diagnostic uncertainty and there is no clear decision to proceed to surgery.

Osteoarthrosis.
Multiple studies documented the ability of ultrasound to identify abnormalities such as effusion (Abicalaf et al., 2021, Bernardo-Bueno et al., 2019, Jiang et al., 2021, Murakami et al., 2017, Saarakkala et al., 2012, Abraham et al., 2011, Ishii et al., 2023). However, false-negative results are common (Saarakkala et al., 2012), and studies do not show the ability to change management of osteoarthrosis. Thus, US is not recommended for patients with osteoarthrosis absent a mechanical issue that may need surgery (e.g., meaningful meniscal tear or cruciate tear). Osteonecrosis. There are no quality studies of US for osteonecrosis and thus it is not recommended.

Anterior knee pain, patellofemoral pain, instability: One study suggested the ability to identify causes of anterior knee pain, including effusion, trochlear cartilage defect and quadriceps tendinopathy (Basha, 2020). Others reported the ability to determine the patellar-trochlear distance (Pacini et al., 2023), patellar tendon thickness in patellar tendinopathy (Hjortshoej et al., 2024), quadriceps tendon thickness in patellofemoral pain syndrome (Kızılkaya et al., 2019), lateral retinaculum thickness in patellofemoral pain (Schoots et al., 2013), and pes anserine bursitis. There are no clear US findings that beget a change in management and thus there is no recommendation for US.

Hamstring strains and other muscle tears.
US has been evaluated in a few studies of hamstring and other muscle tears (Wada et al., 2024, Hirahata et al., 2025), although US may be of assistance to help define the degree of muscle tear; thus, US is recommended for select cases where there is uncertainty regarding the degree of tear and whether surgery is needed.

Evidence

A comprehensive literature search was conducted using PubMed, CINAHL, Cochrane Library, and Google Scholar with date limits of 2011 to the present using the following terms: ultrasonography; patellofemoral pain syndrome, knee osteoarthrosis, knee pain, rheumatic diseases, meniscus, meniscal tear, acute knee pain, chronic knee pain; diagnosis, diagnostic, sensitivity, specificity, positive predictive value, negative predictive value, predictive value of tests, efficacy, and efficiency. We found and reviewed 663 articles in PubMed using Most Recent tab, and we did a secondary search in PubMed using Best Match tab to find and review 663 articles, 53 in CINAHL, 75 in Cochrane Library, 151 in Google Scholar, and 12 from other sources†. We considered for inclusion 4 from PubMed, 2 from CINAHL, 1 from Cochrane Library, 3 from Google Scholar, and 12 from other sources. Of the 22 articles considered for inclusion, 20 diagnostic studies and 2 systematic reviews met the inclusion criteria.

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Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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TREATMENT RECOMMENDATIONS

ACTIVITY MODIFICATION AND EXERCISE

Activities and activity alterations are typically managed differently in patients with acute and chronic knee pain. Patients with acute knee pain may benefit from activity limitations, whereas patients with chronic knee pain almost never improve with activity limitations. Acute knee pain often improves with avoidance of occupational and non-occupational activities that result in *substantial* increases in pain. However, even in the acute pain setting, appropriate activity alterations are difficult to identify. For example, prolonged inactivity of any musculoskeletal pain usually results in increased pain upon movement. It is easy to erroneously conclude the activity aggravated the pain. Even in the acute setting, however, some activity is usually desirable. In general, activities causing a *significant* increase in knee symptoms should be reviewed with the patient and modifications advised when appropriate. These activities may include stair climbing, kneeling, squatting, walking, lifting, and frequency of postural changes.

Chronic knee pain is managed differently. Almost invariably, rehabilitation of chronic knee pain involves gradually performing the occupational and non-occupational activities that result in increased pain in order to improve function. The same types of limitations may be reasonable, but progressive increases in activity frequency, intensity and/or durations is generally necessary to rehabilitate these problems.

Work limitations should take into account four main factors: 1) the job physical requirements; 2) the severity of the problem; 3) work organizational issues (e.g. ability to control job or tasks, overtime, work allocation, wage incentives); and 4) the patient's understanding of their condition. Sometimes it is necessary to write limitations or prescribe activity levels that are above what the patient feels they can do, particularly for patients who believe they should remain sedentary. Progressively increased activity is important, and restrictions that state "sedentary work" are *not* appropriate for most knee patients. Physicians should recognize that a patient's expectations regarding return-to-work status are often set prior to the first appointment [(539)], and therefore education may be necessary

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to set realistic expectations and goals. It is best to communicate early in the treatment that limitations will be progressively reduced as the patient progresses. This should be reiterated at each successive visit so that the patient is well advised in advance of the treatment plan.

There are no quality studies of restrictions, so determining appropriate restrictions is often left to clinical judgment. Assessment of work activities and potential for modifications may be facilitated by a worksite visit and analysis by a clinician with appropriate training (e.g., occupational therapist, physical therapist, physician, or ergonomist). Common limitations involve stair climbing and modifying the weight of objects lifted, frequency of lifts, and posture while taking into account the patient's capabilities. For severe cases of acute knee pain, initial modification of occupational and non-occupational activities often includes:

- frequent alternation of sitting and standing;
- no lifting more than 10 pounds;
- no prolonged or repeated knee bending (flexion);
- no prolonged or repeated crouching and squatting;
- avoidance of ambulation on slippery surfaces or uneven ground; and
- avoidance of frequent stairs.

These work and home activity guidelines are generally reassessed every week in the acute phase. Gradual increases in activity levels are recommended with a goal of returning to full duty in 6 to 12 weeks. The amount of weight handled can be progressively increased. Alternatively, patients can be returned to 1 to 2 hours a day of prior full duty work, with the remainder of the day spent at modified duty. The numbers of hours of full duty work can be increased every 1 to 2 weeks. Individualization of management plans is often necessary. For example, if prior job physical tasks involved frequent lifting of more than 100 pounds, then restricted work guidance may be substantially greater (e.g., 25 pounds of lifting and carrying at first). For workers who have control over their job tasks, assistance from someone else and alternating between sitting and standing as needed, may be included in the management plan.

It should be noted that some workplaces provide healthcare or rehabilitation therapy on-site, so brief periods of recumbent time during the day and on-site physical or occupational therapy may be possible. The physician should make it clear to patients and employers that:

- prolonged walking, jumping, running, kneeling, squatting (e.g., public safety officers), and/or stair climbing may aggravate symptoms;
- moderately heavy lifting, carrying, or working in awkward positions may aggravate symptoms; and
- any restrictions are intended to allow for recovery and time to build activity tolerance through structured exercise.

It is in the patent's best interest for the short- and long-term to maintain maximal levels of activity, including work activity. Written guidance on activity limitations, when applicable, communicates the status of the patient to the employer and gives the patient information on what they should or should not do both at work and at home.

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EDUCATION

EDUCATIONAL SESSIONS FOR TREATMENT OF KNEE OSTEOARTHROSIS

Sometimes Recommended

Educational sessions are selectively recommended to help facilitate treatment of knee osteoarthrosis. Education as part of prehabilitation before arthroplasty is recommended for all patients (see separate recommendation).

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Knee osteoarthrosis.

Frequency/Dose/Duration

One to 3 sessions over 6 weeks are recommended, primarily to facilitate an active exercise program and compliance. While content of educational sessions may include self-management, activity modification, joint protection, and ergonomics, it is suggested to be primarily focused on active exercises rather than passive interventions or disease pathophysiology, particularly as compliance is challenging and periodic encouragement is often required to overcome incapacity and reluctance among patients with severe osteoarthrosis. Further recommendations are to provide psychosocial interventions, lifestyle management interventions, and interventions to support functional performance including and beyond the worker role.

Indications for discontinuation

Noncompliance, failure to improve.

Rationale

Educational sessions have been used for the treatment of knee osteoarthrosis (Salwana Kamsan et al., 2021, Goff et al., 2021, Hamada et al., 2022, Sinatti et al., 2022, Prior et al., 2023, Lesmond et al., 2024). Educational programs are largely ineffective compared to exercise or other active treatments (Ettinger et al., 1997, Rejeski et al., 1997, Mangani et al., 2006, Rejeski et al., 1998, Veenhof et al., 2006). Trials have sometimes employed educational programs as a sham or control treatment. A systematic review concluded there was evidence of low level effects of educational programs and that the differences may not be clinically meaningful (Goff et al., 2021).

However, a few educational visits to emphasize need for exercise and to tailor exercise and other activities are selectively recommended in concert with an exercise prescription, as educational interventions have low adverse effects and are not costly. A primary aim of these sessions is to develop knowledge, self-management, self-efficacy, and encouragement

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of exercises, especially aerobic exercises and strengthening (see separate recommendations for aerobic exercise and strengthening exercise). There is moderate-quality evidence a combination of exercise and weight loss is effective for osteoarthrosis, providing additional rationale for educational interventions targeted at weight loss (Messier et al., 2004, Miller et al., 2003, Rejeski et al., 2002).

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: educational sessions; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 356 articles in PubMed, 134 in CINAHL, 85 in Cochrane Library, 17,600 in Google Scholar, and 0 from other sources†. We considered for inclusion 9 from PubMed, 1 from CINAHL, 2 from Cochrane Library, 4 from Google Scholar, and 0 from other sources. Of the 16 articles considered for inclusion, 10 randomized trials and 6 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

ACTIVITY MODIFICATION

ACTIVITY MODIFICATION FOR KNEE PAIN

Sometimes Recommended

Activities (including work activities) that do not substantially aggravate symptoms are recommended for most patients with acute, subacute, or chronic knee pain. Modification of specific activities is recommended for select patients with significant aggravation of pain due to those discrete activities.

Strength of evidence Recommended, Insufficient Evidence (I)

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Level of confidence Low

Rationale

Activity modification has been used for the treatment of acute, subacute, or chronic knee pain (Kanavaki et al., 2017, Guo et al., 2022). There are no quality studies evaluating modification of activity, including work limitations, for treatment of knee pain due to any disorder.

In common practice, activities that significantly aggravate symptoms are typically restricted. However, limitations need to be monitored, adjusted, and balanced against debility. For example, preoperative limitations are generally not indicated as they may increase debility, increase the length of postoperative recovery, and are often contrary to prehab (which has quality evidence of efficacy). There also is no consensus on post-arthroplasty limitations, as patients increasingly return to high-force, high-endurance active sports, including skiing, bicycling, and running. Some orthopedists apply post-arthroplasty lifting limits of 50 pounds, but these are also frequently based on prior weight-lifting capabilities.

While modification of activity is seemingly without adverse effects, it may result in increased disability through disuse, or increased cardiovascular morbidity through lack of exercise. It also may result in high costs through lost productivity. Thus, implementation of activity modifications should be carefully balanced against increased longer-term morbidity and other costs. In cases where activity does not substantially aggravate the symptoms or disease, activity modifications are not recommended – rather, progressive increased activity is recommended. Modification of specific activities is recommended for those patients with significant aggravation of pain due to those discrete activities.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: activity modification OR exercise, osteoarthritis, knee osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 993 articles in PubMed, 3520 in CINAHL, 232 in Cochrane Library, 17,100 in Google Scholar, and 0 from other sources†. We considered for inclusion 8 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 8 articles considered for inclusion, 6 randomized trials and 2 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full

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evidence base used in this guideline includes all relevant studies identified without date constraints.

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BED REST AND/OR NON-WEIGHT-BEARING FOR UNSTABLE FRACTURES

Recommended

Bed rest and/or non-weight-bearing activities are recommended for patients with clear contraindications to weight-bearing, such as an unstable fracture. Otherwise, bed rest should be avoided for patients without clear contraindications to weight-bearing.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Bed rest and/or non-weight bearing are unlikely to be beneficial and generally should be avoided for all patients other than for those with clear contraindications to weight-bearing, such as evidence of an unstable fracture.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: bed rest, non-weight bearing, NWB, osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1,534 articles in PubMed, 2 in CINAHL, 0 in Cochrane Library, 17,200 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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EXERCISE

AEROBIC EXERCISE FOR KNEE OSTEOARTHROSIS

Recommended

Aerobic exercise is strongly recommended for the treatment of knee osteoarthrosis.

Strength of evidence Strongly Recommended, Evidence (A)
Level of confidence High

Indications

All patients with knee osteoarthrosis. However, those with significant cardiac disease or significant potential for cardiovascular disease may require evaluation prior to instituting vigorous exercises; follow *ACSM's Guidelines for Exercise Testing and Prescription* (12th ed.) (Ozemek C, 2025).

Frequency/Dose/Duration

Dose is somewhat unclear, although the best outcomes appear to be in the higher dose groups, particularly targeting 60-75% of maximum heart rate (Alkatan et al., 2016). A self-directed program is recommended for all patients. Supervised programs may be particularly indicated for those who require supervision to initiate a program or otherwise need assistance with motivation or concomitant fear avoidant belief training. Supervision may be for a few appointments to help initiate the program. The highest quality trial prescribed walking 40 minutes per session, 3 times a week (Ettinger et al., 1997, Rejeski et al., 1997, Mangani et al., 2006, Rejeski et al., 1998). Both of these regimens appear comparable and either is recommended (Minor et al., 1989, Mangione et al., 1999). Nearly all patients should be encouraged to continue aerobic exercises on a long-term basis for fitness purposes, including maintaining lower extremity muscle strength. There are some RCTs suggesting efficacy of distance-based technologies (e.g., text messages, internet-delivered exercise, telehealth) to improve home exercise compliance (Bennell et al., 2022, Bennell et al., 2017, Bennell et al., 2020, Hinman et al., 2020, Mesa-Castrillon et al., 2024, Tore et al., 2023, Thiengwittayaporn et al., 2021); sensor-based technologies also have reported efficacy (Dieter et al., 2025, Davergne et al., 2019, Eboreime et al., 2025).

Indications for discontinuation

Intolerance (rarely occurs), development of other disorders.

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Rationale

Aerobic exercise has been used for the treatment of knee osteoarthritis (Regnaux et al., 2015, Bartels et al., 2016, Alentorn-Geli et al., 2017, Timmins et al., 2017, Van Ginckel et al., 2019, Goh et al., 2019, Turner et al., 2020, Hu et al., 2021, Raposo et al., 2021, Lawford et al., 2024, Xiang et al., 2024, Guede-Rojas et al., 2025, Lu et al., 2024). There are multiple RCTs addressing knee and/or hip osteoarthrosis. Studies compare exercise to non-exercise controls (Petrella, 2000, van Baar et al., 1998, Baker et al., 2001, Halbert et al., 2001, Ettinger et al., 1997, Rejeski et al., 1997, Mangani et al., 2006, Rejeski et al., 1998, Lin et al., 2009, Fransen et al., 2001, Thomas et al., 2005, Thomas et al., 2002, Hay et al., 2006, Nguyen et al., 1997, Ravaud et al., 2004, Thorstensson et al., 2005, Tak et al., 2005, Rogind et al., 1998, Peloquin et al., 1999, Roos et al., 2005, Topp et al., 2002, Hopman-Rock et al., 2000, Jan et al., 2008) (Drummen et al., 2023, Schlenk et al., 2021, Messier et al., 2022, Cheung et al., 2017), exercise to exercise (Hoeksma et al., 2004, McCarthy et al., 2004, Jan et al., 2009, Weng et al., 2009, Deyle et al., 2005, Jessep et al., 2009, Chaipinyo et al., 2009, McKnight et al., 2010)(Alkatan et al., 2016, Kabiri, 2018, Cheung et al., 2017), and exercise to other treatments (Cetin et al., 2008, Kawasaki et al., 2009, Huang et al., 2005, Doi et al., 2008, Karatosun, 2006).

Because there is not a strong rationale for believing that there are major differences in efficacy for hip versus knee OA (see Hip and Groin Disorders guideline) (Roos et al., 2005), and analysis of the available evidence fails to suggest major differences, this summary assumes the outcomes are similar in both sets of patients. Most of the studies considered here combined different exercises. Some exercise programs were unstructured and some studies did not clearly describe the interventions, and these studies are necessarily not relied upon for detailed guidance. Yet, there are many quality studies comparing exercise to non-exercise controls showing superiority of exercise, thus allowing evidence-based conclusions to be made on the relative value of aerobic, stretching, and strengthening exercises. One noteworthy study targeted a dose of 60-75% of heart rate maximum and found comparability between swimming and cycling (Alkatan et al., 2016) and demonstrated strong increases in objective measures of strength and distance walked, as well as strong improvements in pain, stiffness, and quality of life.

A systematic review and network meta-analysis found aerobic exercise was the most beneficial for pain and strengthening exercises were next best for multiple outcomes (Goh et al., 2019). A Cochrane review of knee OA studies concluded there was low to moderate certainty evidence that exercise likely results in pain reductions with exercise along with improved physical function and quality of life (Lawford et al., 2024). Another Cochrane review found low evidence regarding RCT evidence of effects of high- vs. low-intensity exercises for hip or knee OA (Regnaux et al., 2015); however, that preceded some of these published studies.

A high-quality trial of knee osteoarthrosis suggests that while both aerobic and resistance training are helpful, aerobic exercises are modestly superior to resistance training and incrementally more superior to education (Ettinger et al., 1997, Rejeski et al., 1997, Mangani et al., 2006, Rejeski et al., 1998). A moderate-quality trial using a comparable exercise

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regimen also suggests that walking is beneficial (Minor et al., 1989). These studies support the idea that weight bearing is beneficial (Ebert et al., 2008).

All quality studies which included a major component of documented compliance with increased aerobic exercise found benefits of aerobic exercise (Minor et al., 1989, Tak et al., 2005, Hopman-Rock et al., 2000; Alkatan et al., 2016, Drummen et al., 2023, Schlenk et al., 2021). As noted above, the strongest dose of exercise was associated with strong results in all measures (Alkatan et al., 2016), strongly suggesting that exercise dose and intensity are commensurately related to better outcome. Strengthening exercise results appear similar. There is not clear superiority of aerobic or strengthening exercises or vice versa. However, the available quality evidence suggests aerobic and strengthening exercises are superior to flexibility or range-of-motion exercises (Petrella, 2000, Minor et al., 1989). Some, but not all data suggest increased exercise intensity results in superior outcomes. Some, but not all studies that have assessed inflammatory markers and joint scores among those with OA or RA have found reductions in erythrocyte sedimentation rates and lower joint scores among those exercising. Pool-based programs have been evaluated and evidence of superiority of water-based programs is lacking (see Aquatic Therapy). A Cochrane review of exercise for knee OA found platinum (highest) level evidence of modest beneficial effects on knee pain and disability, but unclear evidence on the rate of disease progression (Fransen et al., 2009). A second Cochrane review found equal efficacy for both high- and low-intensity exercise (Brosseau et al., 2003).

Problems with compliance and persistence with exercise programs after discharge are considerable. Evidence is mixed regarding whether supervised exercise programs are necessary or whether home-based programs are sufficient. Clinicians likely need to encourage ongoing compliance with these programs. Exercise programs are not invasive, have low adverse effects, and are low to moderate cost depending on numbers of supervised appointments. Programs emphasizing aerobic and strengthening exercises are recommended, as is stretching for those with substantial reductions in range of motion that do not appear fixed.

Educational programs are largely ineffective compared to exercise or other active treatments (Ettinger et al., 1997, Rejeski et al., 1997, Mangani et al., 2006, Rejeski et al., 1998, Veenhof et al., 2006). Trials have sometimes employed educational programs as a sham or control treatment. However, a few educational visits to emphasize need for exercise and to tailor exercise and other activities are recommended in concert with an exercise prescription, as educational interventions have low adverse effects and are not costly. There is moderate quality evidence a combination of exercise and weight loss is effective for osteoarthrosis, providing additional rationale for educational interventions targeted at weight loss (Messier et al., 2004, Miller et al., 2003, Rejeski et al., 2002)(Hunter et al., 2015, Messier et al., 2022).

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: aerobic exercise, exercise, osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee

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pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1,469 articles in PubMed, 204 in CINAHL, 71 in Cochrane Library, 23,100 in Google Scholar, and 0 from other sources†. We considered for inclusion 23 from PubMed, 2 from CINAHL, 1 from Cochrane Library, 3 from Google Scholar, and 0 from other sources. Of the 29 articles considered for inclusion, 12 randomized trials, and 17 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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STRETCHING EXERCISES FOR KNEE OSTEOARTHROSIS

Sometimes Recommended

Stretching exercises are recommended for select patients with knee osteoarthrosis who have significant reductions in range of motion that are not thought to be fixed deficits.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Patients with significant reductions in range of motion that are thought to be non-fixed deficits (e.g., limitations based on stiffness or disuse rather than osteophytes).

Frequency/Dose/Duration

Generally taught as home exercises over 1 to 3 appointments.

Indications for discontinuation

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Worsening of symptoms, identification that the deficits are fixed, or achievement of exercise program goals.

Rationale

Stretching exercises have been used for the treatment of knee osteoarthrosis (Luan et al., 2022). The available quality evidence suggests aerobic and strengthening exercises are superior to flexibility or range-of-motion exercises (Petrella, 2000, Minor et al., 1989). Thus, stretching or range-of-motion exercises are recommended for select patients with considerable reductions in range of motion that do not appear fixed.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: stretching OR stretch OR muscle stretching Exercises; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 356 articles in PubMed, 16 in CINAHL, 639 in Cochrane Library, 18,300 in Google Scholar, and 0 from other sources†. We considered for inclusion 9 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 10 articles considered for inclusion, 9 randomized trials and 1 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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STRENGTHENING EXERCISES FOR KNEE OSTEOARTHROSIS

Recommended

Strengthening exercises are moderately recommended for treatment of knee osteoarthrosis.

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Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Moderate

Indications

All patients with knee osteoarthrosis are candidates.

Frequency/Dose/Duration

Home program at least 2 to 3 times a week. Supervised treatment frequency and duration is dependent on symptom severity and acuity and the presence of comorbid conditions. There is moderate-quality evidence that isometric exercises are least successful (Huang et al., 2003). May be added with aerobic exercises to an exercise program. In limited circumstances where range-of-motion deficits are considerable but thought to not be fixed, strengthening is sometimes added after beginning flexibility exercises. One moderate-quality trial suggests strengthening exercises are more effective for neutrally aligned knees (Lim et al., 2008). There are some RCTs suggesting efficacy of distance-based technologies (e.g., text messages, internet-delivered exercise, telehealth) to improve home exercise compliance (Bennell et al., 2022, Bennell et al., 2017, Bennell et al., 2020, Hinman et al., 2020, Mesa-Castrillon et al., 2024, Tore et al., 2023, Thiengwittayaporn et al., 2021); sensor-based technologies also have reported efficacy (Dieter et al., 2025, Davergne et al., 2019, Eboreime et al., 2025).

Indications for discontinuation

Development of a strain or failure to improve.

Rationale

(See also the recommendation for Aerobic Exercise.)

Strengthening has been used for the treatment of knee osteoarthrosis (Coudeyre et al., 2016, Culvenor et al., 2017, Kus et al., 2019, Raghava Neelapala et al., 2020, Raposo et al., 2021, Dias et al., 2003, Thomas et al., 2022, Ding et al., 2024, Jiang et al., 2024). Strengthening exercises were assessed in many RCTs, with nearly all reporting superiority to non-exercise control groups (Jorge et al., 2015, Rafiq et al., 2021, Vincent et al., 2020, Lai et al., 2018)(Messier et al., 2021). Other trials compared different strengthening exercise programs (Mamipour et al., 2025, Vincent et al., 2020, Messier et al., 2021, Yuenyongviwat et al., 2020, Rizvi et al., 2023). One trial compared strengthening with yoga and found trends toward superiority of yoga; however, the strengthening did not involve progressive exercise (Abafita et al., 2025). A self-directed online knee strengthening program was also effective (Nelligan et al., 2021). One RCT reported comparable efficacy between a hip adductor vs. hip abductor strengthening program (Almeida, 2022). A crossover trial comparing running, cycling, and control found no evidence of adverse effects of exercise on cartilage biomarkers (Bjerre-Bastos et al., 2025). Multiple studies suggest comparable efficacy between weight-bearing and non-weight bearing exercise programs (Moreira et al., 2021). One study suggested non-weight-bearing quadriceps strengthening was superior to a weight-bearing

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functional exercise program (Khan et al., 2023); however, neither intervention was well described.

A high-quality trial of knee osteoarthrosis suggests that while both aerobic and resistance training are helpful, aerobic exercises are modestly superior to resistance training and superior to education (Ettinger et al., 1997, Rejeski et al., 1997, Mangani et al., 2006, Rejeski et al., 1998). A moderate-quality trial using a comparable exercise regimen also suggests that walking is beneficial (Minor et al., 1989). These studies support the idea that weight bearing is beneficial (Ebert et al., 2008), raise questions about which specific exercises are most beneficial, and suggest that aerobic exercise may be superior for knee osteoarthrosis patients.

All quality studies which included a major component of documented compliance with increased aerobic exercise found benefits of aerobic exercise (Minor et al., 1989, Tak et al., 2005, Hopman-Rock et al., 2000). Strengthening exercise results appear similar. There is not clear superiority of aerobic or strengthening exercises or vice versa. The available quality evidence suggests aerobic and strengthening exercises are superior to flexibility or range-of-motion exercises (Petrella, 2000, Minor et al., 1989). Some, but not all data, suggest increased exercise intensity results in superior outcomes. Some, but not all studies that have assessed inflammatory markers and joint scores among those with OA or RA have found reductions in erythrocyte sedimentation rates and lower joint scores among those exercising. A Cochrane review of exercise for knee OA found platinum (highest) level evidence of modest beneficial effects on knee pain and disability, but unclear evidence on the rate of disease progression. A second Cochrane review found equal efficacy for both high- and low-intensity exercise.

Systematic reviews concluded that there is evidence of efficacy of strengthening for treatment of knee OA, but the overall quality and heterogeneity is such that there is insufficient evidence for specific strengthening regimens (Coudeyre et al., 2016, Guo et al., 2025). One review suggested superiority for isokinetic muscle strengthening (Jiang et al., 2024). There also was felt to be supportive evidence for hip muscle strengthening as a component of knee OA treatment (Raghava Neelapala et al., 2020, Thomas et al., 2022).

Exercise programs that include strengthening exercises are not invasive, have low adverse effects, and are low to moderate cost depending on numbers of supervised appointments. Programs emphasizing aerobic and strengthening exercises are recommended, as is stretching for those with substantial reductions in range of motion that do not appear fixed.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: strength training; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 463

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articles in PubMed, 23 in CINAHL, 125 in Cochrane Library, 17,700 in Google Scholar, and 0 from other sources†. We considered for inclusion 13 from PubMed, 2 from CINAHL, 1 from Cochrane Library, 6 from Google Scholar, and 0 from other sources. Of the 22 articles considered for inclusion, 13 randomized trials and 9 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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GAIT TRAINING FOR KNEE OSTEOARTHROSIS

No Recommendation

There is no recommendation for or against gait training for knee osteoarthrosis.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Gait training has been used for the treatment of knee osteoarthrosis (Tanaka et al., 2016, Richards et al., 2017, Iijima et al., 2019, Byrnes et al., 2022, Rynne et al., 2022, Silva et al., 2022, Hutchison et al., 2023, Tamura et al., 2024, Budarick et al., 2025). Gait training as studied in RCTs is a heterogenous intervention with different techniques, which at least somewhat precludes an assessment of efficacy. Two trials suggested efficacy in comparison with a walking program (Wang et al., 2021) or a sham (Uhlrich et al., 2025). Some trials suggest efficacy compared with non-exercise interventions, including showing that the effects were not sustained (Segal et al., 2015), but these trials are subject to non-interventional biases and do not clearly show efficacy. One trial suggested lack of efficacy for important clinical outcomes (Hunt et al., 2018). Systematic reviews conflict regarding efficacy (Budarick et al., 2025, Silva et al., 2022, Rynne et al., 2022). There are no comparative trials with quality aerobic and strengthening exercises. The evidence is conflicting regarding whether gait training is effective; thus, there is no recommendation for or against gait training for knee OA.

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Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: gait training; osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 409 articles in PubMed, 313 in CINAHL, 98 in Cochrane Library, 32,600 in Google Scholar, and 6 from other sources†. We considered for inclusion 11 from PubMed, 1 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 8 from other sources. Of the 22 articles considered for inclusion, 13 randomized trials and 9 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

AQUATIC THERAPY

Aquatic therapy involves the performance of aerobic and/or flexibility and/or strengthening exercises in a pool to minimize the effects of gravity, particularly where reduced weight-bearing status is believed to be desirable [540,541,542,543]. However, as per the above review of exercise, there is quality evidence that progressive weight-bearing exercise is beneficial for treatment of knee osteoarthrosis.

AQUATIC THERAPY FOR KNEE OSTEOARTHROSIS

Sometimes Recommended

A trial of aquatic therapy is recommended for select patients with knee osteoarthrosis who meet the referral criteria for supervised exercise therapy, have co-morbidities (e.g., extreme obesity, significant degenerative joint disease, etc.) that preclude effective participation in a weight-bearing physical activity, and are planning to transition either to a land-based program or a self-administered water-based program.

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Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Patients with knee OA who cannot tolerate land-based programs (e.g., extreme obesity) and/or who have strong preference for water-based exercises.

Benefits

Compared with a well structured land-based program of progressive aerobic exercises, quadriceps and other strengthening exercises, there may be benefits for a comparatively small group of patients who are either intolerant of the effects of gravity due to, e.g., extreme weight and/or are highly motivated.

Harms

Negligible.

Frequency/Dose/Duration

Begin with 3 to 4 visits a week. Goals should target 60-75% of heart rate maximum (Alkatan et al., 2016). Functional improvement should be documented within the first 2 weeks to justify additional visits. The program should include up to 4 weeks of aquatic therapy with progression towards a land-based, self-directed physical activity or self-directed aquatic therapy program by 6 weeks. For some patients with knee osteoarthrosis, aquatic exercise may be the preferred method. In these cases, the program should become self managed. If any membership to a pool is covered, coverage should be continued if it can be documented that the patient is using the facility at least 3 times a week and following the prescribed exercise program.

Indications for discontinuation

Non-tolerance, failure to progress, or reaching conclusion of program at 4 to 6 weeks.

Rationale

Aquatic therapy has been used for the treatment of knee osteoarthrosis (Lu et al., 2015, Dong et al., 2018, Ma et al., 2022, Mo et al., 2023). Aquatic exercise has been shown to be superior for treatment of knee osteoarthrosis compared to either no therapy (Hinman et al., 2007, Casilda-Lopez, 2017, Waller et al., 2017, Kalkhoran et al., 2025, Rewald et al., 2020) or an education-based program (Dias et al., 2017, Taglietti et al., 2018); however, evidence of superiority to land-based programs is lacking (Minor et al., 1989, Foley et al., 2003, Sylvester, 1990, Khruakhorn et al., 2021). A three-arm comparative trial found multiple measures superior in the resistance exercise group compared with either aquatic exercise and controls (Assar et al., 2020). Instead, most of the quality literature appears to document comparable efficacy between land and water-based exercise programs (Minor et al., 1989,

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Foley et al., 2003, Sylvester, 1990, Alkatan et al., 2016), although almost all of the land-based programs failed to describe clearly progressive strengthening and/or aerobic exercises. However, one trial of swimming vs. cycling that targeted 60-75% of heart rate maximum found comparable efficacy with strong improvements in objective strength measures as well as strong improvements in pain, stiffness, and quality of life (Alkatan et al., 2016), with magnitude of differences considerably stronger than in most other studies. These water programs are performed in lukewarm rather than higher temperature settings to allow for aerobic exercise to be performed. Spa water has been found to be no different than tap water (Yurtkuran et al., 2006), although one study found more durable results with sulfurous water baths (Branco et al., 2016), one found baths superior to no baths (Fioravanti et al., 2010), and another reported better results for balneotherapy versus therapy (Cantista et al., 2020).

Thus, the overall literature quality is relatively poor with many having considerable non-interventional control or usual care group biases. The sole program that included clearly progressive resistance exercises suggested superiority to aquatic exercises (Assar et al., 2020), indirectly suggesting the patient population likely to benefit from aquatic therapy compared with a well-managed land-based program is relatively small. There may be a select minority of patients in whom it is thought to be advantageous to reduce the effects of gravity. A Cochrane review concluded there was moderate-quality evidence that aquatic exercise may have small, short-term benefits regarding patient reported pain, disability, and quality of life (Bartels et al., 2016), with comparable conclusions in a more recent systematic review with meta-analysis (Xu et al., 2023). As noted in other recommendations, other forms of exercise have been shown to be effective in the treatment of knee OA. However, for a few select patients who are unable to tolerate those land-based therapies, aquatic therapy is moderate costly, not invasive, has little potential for adverse effects, and is selectively recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Hydrotherapy, Aquatic Therapy, Aquatic Exercise Therapy; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 137 articles in PubMed, 56 in CINAHL, 20 in Cochrane Library, 17400 in Google Scholar, and 3 from other sources†. We considered for inclusion 2 from PubMed, 2 from CINAHL, 3 from Cochrane Library, 4 from Google Scholar, and 3 from other sources. Of the 14 articles considered for inclusion, 10 randomized trials and 4 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior

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guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens, then the remaining articles are not reviewed due to a lack of relevancy.

YOGA

Yoga has been used successfully for treatment of low back pain [544,545,546] (see Low Back Disorders guideline).

YOGA FOR KNEE PAIN

No Recommendation

There is no recommendation for or against yoga for treatment of chronic knee pain.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Yoga has been used for the treatment of knee osteoarthrosis (Wang et al., 2018, Zampogna et al., 2020, Bhawna et al., 2024, Biswas et al., 2024, Lu et al., 2024, Qiao et al., 2024, Gao et al., 2025). There are a few RCTs of yoga for treatment of knee osteoarthrosis (Cheung, 2017, Bennell et al., 2022, Ebnezar et al., 2011, Vaghela et al., 2020, Abafita et al., 2025) and multiple low-quality studies (Kuntz et al., 2018, Cheung et al., 2014, Cheung et al., 2016). All studies have low to modest sample sizes. One study suggested modest improvements compared with an aerobic/strengthening program (Cheung et al., 2017); however, the aerobic exercise was "mild," and strengthening exercises (while not well described) appear to have also been mild, with neither exercise described in sufficient detail to either replicate any apparent problems with under-dosage.

Compared with education, an unsupervised online yoga program improved physical function but not knee pain (Bennell et al., 2022). Compared with a therapeutic exercise program (no aerobic exercise, ultrasound TENS, possible flexibility exercises), yoga was reportedly modestly superior for pain and general health (Ebnezar et al., 2011, John Ebnezar, 2014). One trial found yoga was not superior to strengthening (Abafita et al., 2025). A trial comparing the additive value of yoga to conventional physiotherapy (TENS, isometric quadriceps exercise, straight leg-raising exercise, knee extension, straight leg abduction exercise) suggested modest improvements in symptoms, although the exercises are insufficiently described for replication and there is no apparent progression (Vaghela et al., 2020).

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Systematic reviews and meta-analyses indicate modest pain reductions (Biswas et al., 2024, Lu et al., 2024) and no improvement in quality of life or ADLs (Lu et al., 2024). The overall database to analyze efficacy of yoga for treatment of knee pain or osteoarthrosis is sparse and poor quality. There is no sham-controlled trial and there is no clear evidence of superiority to a quality aerobic and strengthening exercise program. Yoga may still be appropriate for a few highly motivated patients who both strongly prefer yoga and have reasons for not engaging in progressive aerobic and strengthening exercises that include weights/machines. Thus, there is no recommendation for or against yoga.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: yoga, yoga therapy, yoga exercise; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 46 articles in PubMed, 20 in CINAHL, 9 in Cochrane Library, 13,900 in Google Scholar, and 0 from other sources†. We considered for inclusion 8 from PubMed, 0 from CINAHL, from Cochrane Library, 7 from Google Scholar, and 0 from other sources. Of the 15 articles considered for inclusion, 10 randomized trials and 5 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ERGONOMIC INTERVENTIONS

The physician may recommend ergonomic redesign of the workplace to facilitate recovery and prevent recurrence of knee disorders [(547)]. Ergonomic evaluations of the workplace can be conducted on-site by a qualified professional such as an ergonomist, occupational or physical therapist, or other health safety specialist. There are no quality studies regarding

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ergonomic interventions to prevent knee conditions, nor are there quality studies regarding return to work and secondary prevention. Thus, suggested changes to the work environment are empiric. Knee protection for kneeling or limitations in squatting activities is recommended. Falls result in considerable knee morbidity (including fractures), and fall protection equipment has resulted in far fewer fatalities in industry over the past few decades [548].

ERGONOMIC INTERVENTIONS FOR MUSCULOSKELETAL KNEE DISORDERS

No Recommendation

There is no recommendation for or against the use of ergonomic interventions for musculoskeletal knee disorders.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Ergonomic interventions for prevention of spine and upper extremity disorders have been attempted in numerous occupational settings, and RCTs of ergonomic interventions in these settings have been reported. However, there are no quality studies of ergonomic interventions for the prevention of knee disorders, few studies seeking associations, and no clear benefits (Chanchai et al., 2016, Comper et al., 2017, Giagio et al., 2019, Valipour et al., 2023, Ya'acob et al., 2018, Santos et al., 2025; Skovlund et al., 2025). In the upper extremity, some interventions that had been thought to be beneficial were found to be unhelpful. Thus, without quality evidence, there is no recommendation for or against ergonomic interventions for prevention of knee MSDs. There is one low quality study suggesting a participatory ergonomics approach had value among para-rubber farmers with knee OA (Tangadulrat et al., 2019). Although there is no quality evidence for fall protection in preventing knee disorders, falls from heights continue to cause morbidity and deaths, and fall protection is therefore recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ergonomics OR ergonomic intervention; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 167 articles in PubMed, 299 in CINAHL, 67 in Cochrane Library, 17,300 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 0 randomized trials and 1 systematic review met the inclusion criteria.

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Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

KNEE PADS FOR KNEELING ACTIVITIES

Recommended

Knee pads are recommended for activities that require kneeling.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Ergonomic interventions for spine and upper extremity disorders have been attempted in numerous occupational settings (Verhagen et al., 2006), and RCTs of ergonomic interventions in these settings have been reported. However, there are few quality studies of ergonomic interventions for the lower extremity, and none of knee pads. A conference proceeding, that was apparently not otherwise published, reported reductions in discomfort among those picking saffron who were assigned to the knee pad group compared with an education pamphlet group (Sadeghi N, 2019). Knee pads are inexpensive, thought to be effective and are comfort measures. There is epidemiological evidence that kneeling is either associated with and/or causes knee OA (see Risk and Causation) and thus knee pads are recommended for kneeling activities.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Knee pad OR Pad OR Padding; controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 106 articles in PubMed, 54 in CINAHL, 171 in

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Cochrane Library, 17,000 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

MEDICATIONS

NSAIDS AND NONOPIOID ANALGESICS

NSAIDs are widely used for treatment of osteoarthrosis (OA) and have been considered efficacious [549,550,551]. Most quality studies have included both knee and hip OA patients; however, outcomes in these two patient populations are similar.

Nonsteroidal anti-inflammatory drugs (NSAIDs) inhibit prostaglandin synthesis, impairing inflammation. There are several classes of NSAIDS: 1) salicylates – aspirin, diflunisal, salicyl salicylate (salsalate); 2) arylalkanoic acids – diclofenac, etodolac, ketorolac, nabumetone, sulindac, tolmetin; 3) 2-arylpropionic acids – ibuprofen, fenoprofen, ketoprofen, naproxen; 4) n-arylanthranilic acids – mefenamic acid; 5) oxicams – piroxicam, meloxicam; 6) COX-2 inhibitors – celecoxib, rofecoxib, etoricoxib; and 7) sulphonanilides – nimesulide.

Acetaminophen is considered an analgesic and not an anti-inflammatory agent. Acetaminophen blocks the activation of COX by another enzyme, peroxidase. Tissues with high levels of peroxidase (i.e., platelets and immune cells) are “resistant” to acetaminophen, but tissues with low levels of peroxidase (i.e., nerve and endothelial cells that participate in pain and fever) are “sensitive” to acetaminophen [552]. There have been recent suggestions that NSAIDs may reduce cartilage synthesis [553]. However, there also are many articles documenting reductions in inflammatory mediators [554,555,556,557,558,559,560].

There are two isoenzymes of cyclooxygenase, COX-1 and Cox-2. NSAIDs are COX (non)selective to different degrees. COX-2 selective agents were designed to reduce inflammation without increasing risks for gastrointestinal (GI) bleeding. It appears that certain COX-2 selective agents may increase the risk of cardiovascular events.

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NSAIDS FOR KNEE PAIN

Recommended

NSAIDs are recommended for treatment of acute, subacute, chronic, or postoperative knee pain.

Strength of evidence Strongly Recommended, Evidence (A)
Level of confidence High

Indications

Acute, subacute, chronic, or postoperative knee pain. OTC agents may suffice and may be tried first, especially in milder cases of pain. Topical agents are an alternative for some knee OA patients, although for patients with systemic osteoarthrosis, oral agents may be preferable to simultaneously treat all joints.

Benefits

Improvements in both pain and reported function compared with placebo. There is not robust evidence of accelerated healing. Reductions in heterotopic bone formation after arthroplasty are also consistently reported.

Harms

Adverse effects become more frequent with increasing age plus comorbidities and particularly include hypertension, diabetes mellitus, history of gastrointestinal bleeding, anticoagulant usage, glucocorticosteroid use, gastroesophageal reflux/heart burn, severe illness, and renal insufficiency. Less common adverse effects include headaches, allergic reactions, nausea, vomiting, diarrhea, constipation, and liver abnormalities. Heart attacks appear increased, especially for more selective COX-inhibitors. Monitoring for adverse effects (i.e., hypertension, renal function,) is especially needed for those at increased risk. Protection against GI bleeding is recommended for those with increased risks, including age and comorbidities (see the following recommendations on gastroprotection). Patients with known cardiovascular disease or multiple risk factors for cardiovascular disease should be counseled about the risks and benefits of NSAID therapy, along with consideration of which medication to use, with best evidence of safety for naproxen (see Rationale below).

Low-quality, observational studies of NSAID use among those with fractures have been interpreted as showing NSAIDs delay bone healing. However, similar types of studies also show delays associated with opioids. Thus, these reports of delayed fracture healing appear likely to be confounded whereby those taking medication are also the ones who have non-unions. However, a large database study reported increased risk of nonunion among those using COX-2 inhibitors or opioid prescriptions raising questions of COX inhibition vs. confounding (George MD, 2020).

Due to the potential adverse effects from chronic use (more than 2 months) of NSAIDs, patients should be periodically monitored for adverse effects such as hypertension, blood

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loss, renal insufficiency (as manifested by an increased creatinine), and hepatic enzyme elevations. Older patients and those with co-morbidities may require more frequent monitoring.

Frequency/Dose/Duration

Per manufacturer's recommendations. As-needed use may be reasonable for many patients. However, nearly all trials used scheduled doses (Vinje et al., 1993). There is some evidence that nocturnal dosing is superior if patient primarily has morning or nocturnal pain (Levi et al., 1985), although this may only apply to agents with shorter half-lives, including indomethacin (Stengaard-Pedersen et al., 2004).

Indications for discontinuation

Resolution of knee pain, lack of efficacy, or development of adverse effects that necessitate discontinuation.

Rationale

NSAIDs have been used for the treatment of acute, subacute, chronic, or postoperative knee pain (Miller et al., 2020, Osani et al., 2020, Huang et al., 2021, Zeng et al., 2021, Zeng et al., 2023, Zeng et al., 2024, Chen et al., 2025, Park et al., 2025). More than 25 high- and moderate-quality placebo-controlled RCTs have reported consistent findings that NSAIDs provide significant albeit overall modest improvements in pain and function among chronic knee (and hip) pain patients, particularly those with osteoarthrosis, although some other disorders are included in some studies (Puopolo et al., 2007, Day et al., 2000, Pope et al., 2004, Golden et al., 2004, Lehmann et al., 2005, Watt et al., 2019, Reginster et al., 2007, Altman et al., 2015, Gibofsky et al., 2014, Gordo et al., 2017, Tannenbaum et al., 2004, Sandelin et al., 1997, Essex et al., 2014, Essex et al., 2016, Fleischmann et al., 2006, Pincus et al., 2004, Schnitzer et al., 2004, Shipley et al., 1983, Berry, 1992, Caroit et al., 1976, Petrick et al., 1983, Kivitz et al., 2001, Yocum et al., 2000, Averbuch et al., 2004, Bingham et al., 2007, Kogstad, 1981, Famaey et al., 1976, Hoyeraal et al., 1993). There are sparse studies of NSAID use for acute and subacute knee pain (Duncan et al., 1988, Mahler et al., 2003, McIlwain et al., 1988); however, by analogy to other MSDs including LBP and other musculoskeletal disorders (e.g., see ankle sprain guidance in the Ankle and Foot Disorders guideline, as well as the Low Back Disorders guideline), knee pain may be predicted to be successfully treated with NSAIDs. Perioperative trials similarly suggest efficacy (Ma et al., 2021, Liu et al., 2018, Hu et al., 2021, Ogilvie-Harris et al., 1985, Dorn et al., 1998), as well as better results for preoperative use compared with postoperative use in head-to-head trials (Ma et al., 2021, Liu et al., 2018, Shao et al., 2020), resulting in customary treatment of operative patients with NSAIDs (sometimes combined with acetaminophen (Lubis et al., 2021)) in both timeframes for purposes of improving pain, function, and reducing heterotopic bone formation among arthroplasty patients (Fransen et al., 2006, Sell et al., 2004, Kjaersgaard-Andersen et al., 1989, Dorn et al., 1998, Persson et al., 1998).There are many different combinations of medications used and route(s) of administration (e.g., IV, PO, intraosseous infiltration) in the perioperative timeframe and an inadequate comparative evidence base to identify the optimal evidence-based management approach (Zhuang et al.,

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2020, Ng et al., 2025, Tammachote et al., 2018, Ma et al., 2021, Liu et al., 2018, Shao et al., 2020, Sell et al., 2004, Motififard et al., 2023, Uribe et al., 2018, Salmons et al., 2021, Ogilvie-Harris et al., 1985). One comparative trial found equivalency between preoperative celecoxib and gabapentin, for which there is strong evidence of perioperative efficacy (Motififard et al., 2023). Quality evidence also supports topical NSAIDs for the knee (see separate recommendation).

There are many quality comparative trials of NSAIDs with no clear, consistent finding of superiority of one NSAID over another (Bellamy et al., 1988, Pincus et al., 2004, Geba et al., 2002, Bradley et al., 1991, Yocum et al., 2000, Kogstad, 1981, Puopolo et al., 2007, Saag et al., 2000, Levenstein, 1985, Zacher et al., 2003, Bellamy et al., 1992, Bellamy et al., 1986, Hawel et al., 2003, Fleischmann et al., 2008, Day et al., 2000, Fioravanti et al., 2002, Le Loet et al., 1997, Leung et al., 2002, Reginster et al., 2007, Kidd et al., 1996, Lisse et al., 2003, Wegman et al., 2003, Smugar et al., 2006, Perpignano et al., 1994, Bellamy et al., 1995, Lussier et al., 1980, Myllykangas-Luosujarvi et al., 2002, Hosie et al., 1996, Herrmann et al., 2000, Ginsberg et al., 1984, Schnitzer et al., 2004, Morgan et al., 2001, Cannon et al., 2000, Alho et al., 1988, Baumgartner et al., 1996, Shipley et al., 1983, Brown et al., 1986, Cardoe et al., 1986, Gordin et al., 1984, Bauer et al., 1999, Adelowo et al., 1998, Ginsberg et al., 1991, Telhag et al., 1981, Corts Giner et al., 1991, Bingham et al., 2007, Kiff et al., 1994, Clarke, 1975, Singer et al., 2000, Meurice, 1983, Kriegel et al., 2001, Keet, 1979, Bjorkenheim et al., 1985, Valtonen, 1979, Liyanage et al., 1977, Lund et al., 1987, Chikanza et al., 1994, McIlwain et al., 1988, The Manchester General Practitioner Group, 1984, Gordin et al., 1985, Verbruggen et al., 1982)(Geba et al., 2002, Lehmann et al., 2005, Gordo et al., 2017, Tannenbaum et al., 2004, Essex et al., 2014, Essex et al., 2016, Birbara et al., 2006, Garg et al., 2017, Sandelin et al., 1997, Fleischmann et al., 2006, Park et al., 2020, Duncan et al., 1988, Schnitzer et al., 2004, Curtis et al., 2005, Ginsberg et al., 1982, Kivitz et al., 2001, Becvar et al., 1999, Onda et al., 2016). There also is no consistent quality evidence suggesting superiority of one NSAID class over another class. However, there is quality evidence that COX-2 selective NSAIDs reduce the risk of gastrointestinal adverse effects (Garner et al., 2005, Berenbaum et al., 2005, Fenton et al., 2004) (Reginster et al., 2007, Lisse et al., 2003). There is quality evidence that NSAIDs are less impairing than opioids, yet efficacy is comparable with no quality evidence of superiority of opioids (See the Opioids Guideline). For most patients, generic ibuprofen, naproxen or other older generation NSAIDs are generally recommended as first-line medications. Second-line medications should generally include other generic medications.

Topical NSAIDs are another option. Evidence suggests topical NSAIDs are superior to acetaminophen but sparse evidence suggests they are not inferior to oral NSAIDs (Zeng et al., 2021, Ling et al., 2020, Persson et al., 2020, Wolff et al., 2021, Wang et al., 2021). Acetaminophen is an option for either sole treatment or adjunctive treatment. However, while acetaminophen has been shown to be superior to placebo, it is consistently shown to be inferior to NSAIDs for pain relief. Suzetrigine is another option for post-operative use, most commonly as adjunctive management. See separate recommendations for these treatments. Opioids are generally not a viable option, other than for limited use for breakthrough post-operative pain (See the Opioids Guideline).

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A systematic review and meta-analysis of observational studies of NSAIDs found that the risk for serious cardiovascular events differed by NSAID, such that it is appears lowest and not elevated for naproxen, while potentially minimally elevated for ibuprofen, piroxicam, celecoxib and valdecoxib, but showing greater risk for etoricoxib, etodolac, diclofenac, and indomethacin (McGettigan et al., 2006) (McGettigan P, 2011, Nissen et al., 2016, Coxib and traditional NSAID Trialists' (CNT) Collaboration et al., 2013, Arnal MJ, 2022). Many of the studies supporting these estimates were based on large pharmaceutical databases that were adequately powered to detect effects, but had limited ability to control for potential confounding, including a potentially fatal flaw of confounding by indication (Trelle S,). There is one reported study of NSAIDs and myocardial infarctions that controlled for two major confounders – aspirin and body mass index (Kimmel et al., 2005) and reported summary estimates for non-selective NSAIDs suggesting that they are protective against cardiovascular events. Study weaknesses included a 50% participation rate and reliance on recall. Thus, current evidence remains somewhat unclear regarding whether there is increased risk, no risk, or reduced risk of cardiovascular events from the use of NSAIDs. It is recommended that potential risks of NSAIDs be discussed with patients, particularly among patients with cardiovascular risk factors.

Risks of gastrointestinal events should be assessed, including prior history of gastrointestinal bleeding and source, length of treatment, age, smoking, diabetes mellitus, and other medical factors. Treatment with either acetaminophen, NSAIDs plus misoprostol, proton pump inhibitors (see below), H2 receptor antagonists, sucralfate, or use of a COX-2 selective agent should be considered in those at high risk for gastrointestinal complications (Lohmander et al., 2005, Garner et al., 2005, Berenbaum et al., 2005, Bocanegra et al., 1998, Lisse et al., 2003, Fenton et al., 2004, Agrawal et al., 1999, Gomes et al., 1993, Hayllar et al., 1996, Becvar et al., 1999, Hoyeraal et al., 1993). An RCT involving 24,081 patients randomized to celecoxib, ibuprofen or naproxen all using low-dose aspirin plus esomeprazole for cytoprotection found clinically significant GI events at 0.34%, 0.74% and 0.66 respectively (Yeomans ND et al., 2018). See separate recommendations on misoprostol, proton pump inhibitors, H2 receptor antagonists, and sucralfate.

NSAIDs are not invasive other than in the operative setting, have low side effect profiles in a healthy working patient population, are low cost when generic medications are used, and have strong evidence of efficacy. However, the improvements in pain and function are typically mild to moderate. Thus, NSAIDs are recommended. Cardiovascular risk should be incorporated, especially for COX-selective agents and among patients at higher risk of adverse effects.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Anti-Inflammatory Agents, Non-Steroidal OR NSAID OR Ibuprofen OR Naproxen OR Diclofenac; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1341 articles in PubMed,

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558 in CINAHL, 2080 in Cochrane Library, 17,600 in Google Scholar, and 0 from other sources†. We considered for inclusion 10 from PubMed, 11 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 0 from other sources. Of the 23 articles considered for inclusion, 17 randomized trials and 6 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

ACETAMINOPHEN FOR KNEE PAIN

Recommended

Acetaminophen is recommended for treatment of acute, subacute, chronic, or postoperative knee pain, particularly for those with contraindications for NSAIDs. It may also be used in combination with an NSAID for management of moderate to severe pain.

Strength of evidence Recommended, Evidence (C)
Level of confidence Low

Indications

All patients with knee pain, including acute, subacute, chronic, and postoperative.

Frequency/Dose/Duration

Per manufacturer's recommendations; may be utilized on an as needed basis. It has been suggested that 1gm doses are more effective than 650-mg doses, particularly in postoperative patients (, 2008, McQuay et al., 2002). However, this dose is now above the maximum dose recommended by an FDA advisory committee of 650 mg, as evidence of hepatic toxicity has been reported at 4 g per day, particularly among those consuming excessive alcohol. There is no quality evidence for superiority of 1-g dosing for treatment of osteoarthrosis.

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Indications for discontinuation

Resolution of pain, adverse effects, or intolerance.

Rationale

Acetaminophen has been used for the treatment of acute, subacute, chronic, or postoperative knee pain (Liang et al., 2017, Sun et al., 2018, Zhu et al., 2018, Leopoldino et al., 2019, Teng et al., 2020, Pop et al., 2025). There are several quality studies of acetaminophen and a few of paracetamol, a close analog. Acetaminophen/paracetamol has been shown to be modestly superior to placebo (Amadio et al., 1983, Pincus et al., 2004), although not all studies are positive (Reed et al., 2018), which is also corroborated by RCTs showing weak efficacy for treatment of low back pain (see Low Back Disorders guideline). All trials that compared acetaminophen with NSAIDs found either that NSAID significantly reduced pain more than acetaminophen or that differences were not statistically significant but favored NSAIDs despite those trials typically using submaximal NSAID dosing (Golden et al., 2004, Temple et al., 2006, Boureau et al., 2004, Case et al., 2003, Geba et al., 2002, Bradley et al., 1991, Blandino, 2001) (Pincus et al., 2001, Williams, 1993, Onda et al., 2016, Doherty et al., 2011). Most of the trials of acetaminophen/paracetamol used doses of 4 g/day, which is no longer advised. There is evidence of superior symptom relief at 2 hours with ibuprofen compared to paracetamol. These findings are consistent with quality evidence for the treatment of low back pain (see Low Back Disorders guideline). Subanalyses have suggested that NSAIDs are particularly more efficacious for those with more severe osteoarthrosis. However, evidence also indicates higher rates of gastrointestinal adverse effects among NSAID users and lower overall adverse effects profiles for acetaminophen. An RCT found lack of efficacy of adjunctive preoperative, one-time use for knee arthroplasty (Wang et al., 2023). Intraoperative IV use has also been attempted with mixed results (O'Neal et al., 2017, Murata-Ooiwa et al., 2017), and a small trial of combination use with ibuprofen reported efficacy (Lubis et al., 2021). A Cochrane review similarly concluded there was evidence of minimal benefit (Leopoldino et al., 2019).

Acetaminophen has evidence of efficacy, is not invasive, has low adverse effect profile in a healthy working patient population, is low cost and is recommended for treatment of patients with knee pain.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar using the following terms: Acetaminophen, Tylenol, Paracetamol; Osteoarthritis, knee osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 113 articles in PubMed, 79 in CINAHL, 40 in Cochrane Library, 18,000 in Google Scholar, and 0 from other sources†. We considered for inclusion 4 from PubMed, 1 from CINAHL, 0 from Cochrane Library, 3 from Google Scholar, and 4 from other sources. Of

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the 12 articles considered for inclusion, 5 randomized trials and 7 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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TOPICAL NSAIDS FOR KNEE PAIN

Recommended

Topical NSAIDs are recommended for treatment of acute, subacute, and chronic knee pain. They may be a reasonable option for select post-operative patients, although there are wound care considerations that may limit their use, such as to areas of the joint away from the incision.

Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Moderate

Indications

Acute, subacute, chronic, or postoperative knee pain. There may be wound care considerations for postoperative patients. For patients with systemic osteoarthrosis, oral agents may be preferable to simultaneously treat all joints.

Benefits

Pain reduction, increased function and fewer adverse effects that with use of oral NSAIDs.

Harms

Skin irritation. Lower risks than with oral NSAIDs, but still potential adverse effects especially with higher dose/larger area usage include gastrointestinal, renal and cardiovascular effects.

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Rare serious effects reportedly include angioedema, anaphylaxis, Stevens-Johnson syndrome.

Frequency/Dose/Duration

Per manufacturer's recommendations. As-needed use may be reasonable for many patients.

Indications for discontinuation

Resolution of knee pain, lack of efficacy, or development of adverse effects that necessitate discontinuation.

Rationale

Topical NSAIDs have been used for the treatment of acute, subacute, chronic, or postoperative knee pain (Lin et al., 2004, Biswal et al., 2006, Towheed, 2006, Makris et al., 2010, Deng et al., 2016, Sardana et al., 2017, Persson et al., 2018, Zheng et al., 2018, Honvo et al., 2019, Ling et al., 2020, Persson et al., 2020, Chen et al., 2025). Placebo-controlled trials consistently suggest efficacy of topical NSAIDs for treatment of knee pain (Niethard et al., 2005, Trnavský et al., 2004, Bookman, 2004, Bihlet et al., 2020, Varadi et al., 2013, Conaghan et al., 2013, Li et al., 2024, Kneer et al., 2013, Yataba et al., 2017, Wadsworth et al., 2016, Sandelin et al., 1997, Barthel et al., 2009, Baraf et al., 2010, Roth et al., 2004, Brühlmann et al., 2003, Baer et al., 2005); there were two studies that were negative (Rother et al., 2013, Ottillinger et al., 2001). Mechanistically, one study measured detectable drug showing penetration into synovial fluid (Seefried, 2020). Equivalent efficacy has been consistently shown when comparing oral NSAIDs with topical NSAID preparations (Conaghan et al., 2013, Tugwell et al., 2004, Sandelin et al., 1997, Simon et al., 2009, Doi et al., 2010, Underwood et al., 2008). Comparable efficacy has been suggested in comparisons with herbal and homeopathic preparations, however, unblinding appears likely in at least some of these (Shoara et al., 2015, Hanprasertpong et al., 2017, Koonrungsesomboon et al., 2020, Koonrungsesomboon et al., 2022, Saereewat et al., 2024, Van Haselen et al., 2000). There are various methods of delivery of topical NSAIDs (e.g., creams, plasters, patches) and no significant evidence these methods materially differ in efficacy.

Systematic reviews and metanalyses have drawn similar conclusions, suggesting that topical NSAIDs are superior to acetaminophen but sparse evidence suggests they are not inferior to oral NSAIDs (Zeng et al., 2021, Ling et al., 2020, Persson et al., 2020, Wolff et al., 2021, Wang et al., 2021) (see separate recommendation).

Topical NSAIDs have evidence of efficacy, are not invasive, have low adverse effects which include lower GI adverse effects than oral NSAIDs, are low to moderate cost depending on length of treatment and thus are recommended for acute, subacute, chronic, and select postoperative patients.

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: non-steroidal anti-inflammatory drugs, topicals nsaids, nsaids; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 3,132 articles in PubMed, 212 in CINAHL, 28 in Cochrane Library, 15,900 in Google Scholar, and 4 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 2 from Cochrane Library, 40 from Google Scholar, and 0 from other sources. Of the 56 articles considered for inclusion, 43 randomized trials and 13 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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SUZETRIGINE FOR KNEE PAIN

Sometimes Recommended

Suzetrigine is selectively recommended for management of acute or perioperative knee pain that is either not managed adequately by NSAIDs or for whom there are contraindications for use of NSAIDs.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Suzetrigine is selectively recommended for treatment of acute or perioperative pain that is either not sufficiently managed by NSAIDs or for whom there are contraindications for the use of NSAIDs (e.g., allergies). May be combined with an NSAID prescription and potentially acetaminophen to manage severe pain.

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Benefits

Reduced pain, potential for reductions in use of opioids.

Harms

Pruritus, muscle spasms, increased blood creatine phosphokinase, and rash. There are drug interactions with CYP3A inhibitors.

Frequency/Dose/Duration

Two 50-mg tabs followed by 50 mg every 12 hours. Duration of use is approved for 14 days.

Indications for discontinuation

Intolerance, adverse effects, noncompliance, sufficient reduction or resolution of pain.

Rationale

There are few quality trials, mostly involving surgical patients (McCoun, 2025, Bertoch, 2025). Data suggest modest reductions in pain associated with use of suzetrigine. Suzetrigine is not invasive, has low adverse effects, is moderate to high cost depending on duration of use, and thus is selectively recommended for treatment of acute or perioperative pain that is either not sufficiently managed by NSAIDs or for whom there are contraindications for the use of NSAIDs (e.g., allergies). Suzetrigine may be combined with an NSAID prescription to manage severe pain.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: suzetrigine, Journavx; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in CINAHL, 0 in Cochrane Library, 58 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 4 from Google Scholar, and 0 from other sources. Of the 4 articles considered for inclusion, 3 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full

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evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

PROTON PUMP INHIBITORS FOR NSAID CYTOPROTECTION

Recommended

Proton pump inhibitors (esomeprazole, lansoprazole, omeprazole, pantoprazole, rabeprazole) are recommended for cytoprotection among patients who are at increased risk of gastrointestinal bleeding from NSAID medications.

Strength of evidence Strongly Recommended, Evidence (A)
Level of confidence High

Indications

Patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications, particularly if longer-term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, advanced age, diabetes, and cigarette smoking.

There are four commonly used cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers (famotidine, ranitidine, cimetidine, etc.), and proton pump inhibitors (esomeprazole, lansoprazole, omeprazole, pantoprazole, rabeprazole). Evidence suggests that histamine-2 blockers are less effective for protection of the gastric mucosa and sucralfate is the weakest of these compared with proton pump inhibitors or misoprostol. There also are combination products of NSAIDs/misoprostol that have documented reductions in the risk of endoscopic lesions.

Benefits

Reduced risk of gastric ulcers, duodenal ulcers, small bowel ulcers, bowel perforations and gastrointestinal bleeding.

Harms

Generally minor adverse effects. PPIs have long term risks of fractures, hypomagnesemia, QT prolongation, kidney disease, vitamin B12 deficiency, iron deficiency.

Frequency/Dose/Duration

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As recommended by manufacturer. Duration is the extent of the NSAID therapy; use may at times be long-term for those with recurrent bleeds or other complications.

Indications for discontinuation

Resolution of need for NSAID, discontinuation of NSAID, adverse effects, non-compliance.

Rationale

Proton pump inhibitors have been used for patients at risk for GI adverse effects (Garegnani et al., 2025). Multiple high- and moderate-quality placebo-controlled RCTs have consistently reported proton pump inhibitors are associated with large reductions in risk of gastric and duodenal ulcers among patients taking NSAIDs (Scheiman et al., 2006)(Yeomans et al., 2008, Bianchi Porro et al., 1998, Bianchi Porro et al., 2000, Hawkey et al., 2005, Cullen et al., 1998, Desai et al., 2008, Graham et al., 2002), supporting strong evidence of efficacy. Comparative trials have suggested pantoprazole is superior to misoprostol, while pantoprazole but not lansoprazole has been reported to be modestly superior to misoprostol (Stupnicki et al., 2003, Graham et al., 2002). No difference was found between famotidine and lansoprazole in a study that is likely underpowered (Miyake K, 2005)(Stupnicki et al., 2003), while durability of gastric ulcer-free status is superior with misoprostol compared with lansoprazole (Graham et al., 2002) Comparative studies of proton pump inhibitors have not found superiority of one medication over another (Regula et al., 2006, Scheiman et al., 2006).

A Cochrane review concluded there is evidence of likely reduction in risk of ulcers (RR=0.29) and ulcer complications (RR=0.33) (Garegnani et al., 2025).

Risks of gastrointestinal events should be assessed, including prior history of gastrointestinal bleeding and source, length of treatment, age, smoking, diabetes mellitus, and other medical factors. Treatment with either acetaminophen, NSAIDs plus misoprostol, proton pump inhibitors, or a COX-2 selective agent should be considered in those at high risk for gastrointestinal complications (Lohmander et al., 2005, Garner et al., 2005, Berenbaum et al., 2005, Bocanegra et al., 1998, Lisse et al., 2003, Agrawal et al., 1999, Gomes et al., 1993, Hayllar et al., 1996, Becvar et al., 1999, Hoyeraal et al., 1993).

There is strong evidence of efficacy for oral proton pump inhibitors which are also mostly not invasive (IV preparations are available), have low adverse effects, are low to moderate cost depending on duration of treatment and are recommended for prevention of GI bleeding.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Protein Pump Inhibitors, PPI, Non-Steroidal Anti-Inflammatory Drugs, NSAID; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical

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trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 7 articles in PubMed, 112 in CINAHL, 4 in Cochrane Library, 17,700 in Google Scholar, and 0 from other sources†. We considered for inclusion 2 from PubMed, 1 from CINAHL, 1 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 4 articles considered for inclusion, 3 randomized trials and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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MISOPROSTOL FOR NSAID CYTOPROTECTION

Recommended

Misoprostol is recommended for prevention of ulcers among patients on NSAIDs.

Strength of evidence Strongly Recommended, Evidence (A)
Level of confidence High

Indications

Patients at increased risk of ulcers from NSAIDs.

Benefits

Reduced risk of gastric or duodenal ulcers.

Harms

Nausea, vomiting, diarrhea, abdominal pain, cramping, indigestion, chills, shivering, fever, vaginal bleeding, abortion, premature birth, birth defects, vaginal bleeding, menstrual

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irregularities, headache, dizziness, fatigue, weakness, myocardial infarction, pulmonary embolism, allergic reactions.

Frequency/Dose/Duration

100-200 mcg 4 times daily.

Indications for discontinuation

Cessation of NSAID usage, adverse effects, noncompliance.

Rationale

Multiple high-and moderate-quality placebo-controlled RCTs show misoprostol consistently provides substantial reductions in risks for gastric ulcers, duodenal ulcers, and perforations among both patients and healthy subjects taking NSAIDs (Agrawal et al., 1999, Raskin et al., 1995, Bocanegra et al., 1998, Bardhan et al., 1993, Graham et al., 1993, Graham et al., 2002, Elliott et al., 1994, Jiranek et al., 1989, Lanza et al., 1988, Silverstein et al., 1986, Donnelly et al., 2000, Koch et al., 2000, Medina Santillan et al., 1999). Only one study was negative, but also was a small-sized, likely underpowered trial (Chandrasekaran et al., 1991). One study also suggested efficacy for prevention of small bowel ulcers (Taha, 2018). Comparative trials suggested misoprostol is inferior to pantoprazole (Stupnicki et al., 2003), while also suggesting superiority to sucralfate (Agrawal et al., 1991).

A Cochrane review quantified benefits at doses of both 400 mcg/day (RR=0.39) and 800 mcg/day (RR=0.17) (Rostom A, 2002). Other systematic reviews also conclude there is evidence of efficacy (Mitsuboshi S, 2023) and some evidence for reducing NSAID-related renal impairments (Mitsuboshi S, 2023).

Misoprostol has strong evidence of efficacy, is not invasive, has some adverse effects, is low cost, and thus is recommended for patients who are at increased risk of gastrointestinal bleeding.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: misoprostol; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 697 articles in PubMed, 1 in CINAHL, 12 in Cochrane Library, 838 in Google Scholar, and 0 from other sources†. We considered for inclusion 1 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trial and 0 systematic reviews met the inclusion criteria.

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Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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SUCRALFATE FOR NSAID CYTOPROTECTION

Recommended

Sucralfate is recommended to prevent ulcers and gastrointestinal bleeding, although evidence shows other medications are superior.

Strength of evidence Recommended, Evidence (C)
Level of confidence Low

Indications

Patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, the elderly, diabetics, and cigarette smokers. However, other medications are superior to sucralfate for this purpose.

There are four commonly used cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers (famotidine, ranitidine, cimetidine, etc.), and proton pump inhibitors (esomeprazole, lansoprazole, omeprazole, pantoprazole, rabeprazole). Evidence suggests that histamine-2 blockers are less effective for protection of the gastric mucosa and sucralfate is the weakest of these compared with proton pump inhibitors or misoprostol. There also are combination products of NSAIDs/misoprostol that have documented reductions in the risk of endoscopic lesions.

Benefits

Prevention of GI bleeding and ulcers.

Harms

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Negligible. Constipation, nausea, vomiting, diarrhea.

Frequency/Dose/Duration

1 gm QID

Indications for discontinuation

Completion of course of NSAIDs, intolerance, noncompliance.

Rationale

There are a few studies of sucralfate, with multiple moderate quality placebo-controlled trials showing evidence of efficacy ((Miglioli et al., 1996) (Caldwell JR, 1987, Lanza et al., 1988). However, comparative trials show evidence of considerable inferiority to misoprostol (Lanza et al., 1988, Agrawal et al., 1991). There is quality evidence that sucralfate reduces the risk of GI bleed/ulcers, has low adverse effects, is low to moderate cost and is recommended for prevention of GI bleeding. While the main advantage of sucralfate is its low adverse effect profile due to not being absorbed, it has also been shown to be considerably less effective than either proton pump inhibitors or misoprostol.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: sucralfate, GI adverse effects; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 5 articles in PubMed, 0 in CINAHL, 3 in Cochrane Library, 392 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

H2 BLOCKERS FOR NSAID CYTOPROTECTION

Recommended

H2 blockers are recommended for prevention of gastrointestinal bleeding and ulcers among patients taking NSAIDs who are at increased risk for these adverse events.

Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Moderate

Indications

Patients with a high-risk factor profile who also have indications for NSAIDs, cytoprotective medications, particularly if longer term treatment is contemplated. At-risk patients include those with a history of prior gastrointestinal bleeding, the elderly, diabetics, and cigarette smokers.

There are four commonly used cytoprotective classes of drugs: misoprostol, sucralfate, histamine Type 2 receptor blockers (famotidine, ranitidine, cimetidine, etc.), and proton pump inhibitors (esomeprazole, lansoprazole, omeprazole, pantoprazole, rabeprazole). Evidence suggests that histamine-2 blockers are less effective for protection of the gastric mucosa and sucralfate is weaker than proton pump inhibitors or misoprostol. There also are combination products of NSAIDs/misoprostol that have documented reductions in the risk of endoscopic lesions.

Benefits

Reduced risk of GI bleeding and ulcers.

Harms

Headache, dizziness, lightheadedness, fatigue, drowsiness, constipation, diarrhea, dry mouth, muscle aches, confusion, hallucinations, seizures, depression, palpitations, rash, allergic reactions. Cimetidine may cause gynecomastia and impotence; ranitidine is associated with porphyria. Drug-drug interactions can affect absorption of other medications and vitamin B12 absorption.

Frequency/Dose/Duration

Per manufacturers' recommendations.

Indications for discontinuation

Resolution of need for NSAID, discontinuation of NSAID, adverse effects, noncompliance.

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Rationale

Moderate-quality RCTs show evidence of efficacy of H2 blockers in comparison with placebo to prevent GI ulcers among those using NSAIDs (Lanza et al., 1988, Taha AS, 1996, Levine LR, 1993, Laine L, 2011, Laine L, 2012)(Robinson et al., 1991, Robinson et al., 1989, Ehsanullah et al., 1988). Multiple RCTs also suggest that misoprostol is superior to H2 blockers (Bianchi Porro et al., 1997, Raskin et al., 1996, Lanza et al., 1988). There are relatively few quality trials comparing efficacy of the different classes of agents. Pantoprazole but not lansoprazole has been reported to be modestly superior to misoprostol (Stupnicki et al., 2003, Graham et al., 2002). No difference was found between famotidine and lansoprazole (Miyake K, 2005).

H2 blockers have quality evidence of efficacy, have low adverse effects, are low cost depending on length of treatment and are recommended for use among patients on NSAIDs for prevention of GI bleeds and ulcers. However, there is evidence suggesting better efficacy with proton pump inhibitors and misoprostol.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Anti-Inflammatory Agents, Non-Steroidal OR NSAID OR Ibuprofen OR Naproxen OR Diclofenac; Histamine H2 Antagonists, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 6 articles in PubMed, 1 in CINAHL, 0 in Cochrane Library, 16,000 in Google Scholar, and 0 from other sources†. We considered for inclusion 1 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 articles considered for inclusion, 1 randomized trials and 0 systematic reviews met the inclusion criteria. Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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OPIOIDS

Opioids are addressed in a separate guideline. See the ACOEM Opioids guideline for all recommendations and supporting evidence.

MUSCLE RELAXANTS

Skeletal muscle relaxants comprise a diverse set of pharmaceuticals designed to produce muscle relaxation through different mechanisms of action, including central nervous system (CNS) mechanisms [561,562]. These medications are widely used in primary care to treat painful conditions, including LBP [563,564,565,566,567,568,569], muscle spasms [570], and myalgias. They are generally not used for treatment of knee disorders.

MUSCLE RELAXANTS FOR KNEE PAIN

No Recommendation

There is no recommendation for or against the use of muscle relaxants for treatment of acute or subacute, moderate to severe knee pain that is unrelieved by NSAIDs, avoidance of exacerbating exposures, or other conservative measures (generally not indicated for chronic knee pain). There are other indications for muscle relaxants.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Frequency/Dose/Duration

Initial dose in evening (not during workdays or if patient operates a motor vehicle, though daytime use is acceptable if CNS-sedating effects are minimal). Duration for exacerbations of chronic pain is limited to a couple weeks. Longer term treatment is generally not indicated.

Indications for discontinuation

Resolution of pain, non-tolerance, significant sedating effects that carry over into the daytime, other adverse effects.

Rationale

Skeletal muscle relaxants have been used for knee pain (Courseau et al., 2018, Zhai et al., 2020, Gagnière et al., 2025). There are no quality studies of skeletal muscle relaxants for treatment of patients with knee pain. Skeletal muscle relaxants have been evaluated in quality studies evaluating acute LBP, chronic back and neck pain (Brown et al., 1978, Hingorani, 1971, Bercel, 1977, Salzmann et al., 1992) (see the Chronic Pain and Low Back Disorders guidelines). The quality of the studies comparing these agents to placebo is limited due to probable unblinding from adverse effects. The adverse effect profile is concerning (Littrell et al., 1993), with CNS sedation rates ranging from approximately 25 to 50% and a low but definite risk of abuse (Littrell et al., 1993, Toth et al., 2004). Thus, prescriptions for skeletal muscle relaxants for daytime use should be carefully weighed against the need to drive vehicles, operate machinery, or otherwise engage in occupations

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where mistakes in judgment may have serious consequences (e.g., crane operators, air traffic controllers, operators of motorized vehicles, construction workers, etc.).

Skeletal muscle relaxants have beneficial uses, particularly for nocturnal administration to normalize sleep patterns disrupted by skeletal muscle pain, as well as for daytime use among the few patients who do not suffer from the CNS depressant effects. Skeletal muscle relaxants have no evidence of efficacy for knee disorders, are not invasive, have significant adverse effects, and are low cost (if generic medications are prescribed). Thus, there is no recommendation for or against their use. There are other indications for these medications.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Skeletal muscle relaxants, antispasmodics, spasmolytics, neuromuscular agents; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, muscle spasms; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 114 articles in PubMed, 10 in CINAHL, 24 in Cochrane Library, 8,960 in Google Scholar, and 1 from other sources†. We considered for inclusion 5 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 1 from other sources. Of the 7 articles considered for inclusion, 4 randomized trials and 3 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ANTIDEPRESSANTS

Antidepressants have been used for treatment of chronic pain disorders.

ANTIDEPRESSANTS FOR KNEE OSTEOARTHROSIS OR KNEE PAIN

No Recommendation

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There is no recommendation for or against the use of antidepressants for treatment of knee osteoarthrosis or knee pain.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Duloxetine has been used in moderate-quality RCTs for potential adjunctive osteoarthrosis pain reduction (Abou-Raya et al., 2012, Uchio et al., 2018, Enomoto et al., 2018, Chappell et al., 2011, Wang et al., 2017, Petersen et al., 2022). Problems with adverse effects have been noted (Osani et al., 2019). One trial found additive benefit to corticosteroid plus hyaluronic acid injection (Li et al., 2024). One trial found a failure to provide additive benefits to usual care (van den Driest et al., 2022).

Duloxetine also has been perioperatively used as a potential opioid-sparing medication (YaDeau et al., 2016, Pinsornsak et al., 2024, Yuan et al., 2022, Masoumi et al., 2025, Kim et al., 2021, Rienstra et al., 2021), similar to gabapentin (Masoumi et al., 2025), although there is a far larger body of evidence for gabapentin (see separate recommendation). Most trials suggested modest efficacy, while one trial was negative (YaDeau et al., 2016). The overall body evidence suggests reductions in opioids use, but effects on pain appear not significant (Azimi et al., 2023). There are many other perioperative management strategies that have lower adverse effects, the body of evidence is sparse compared with gabapentin, the evidence regarding gabapentin is unclear regarding clinical significance; thus, there is no recommendation for the perioperative use of duloxetine.

There are few quality studies of the use of antidepressants to treat osteoarthrosis, and the available evidence mostly suggests potential modest improvements in pain. Studies are mostly 3 months duration, which is insufficient for a long-term problem such as osteoarthrosis. As well, there are significant adverse effects; thus, there is no recommendation.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Noradrenaline Reuptake Inhibitors, Desvenlafaxine Succinate, Duloxetine Hydrochloride, Levomilnacipran, Venlafaxine Hydrochloride; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 58 articles in PubMed, 9 in CINAHL, 1 in Cochrane Library, 392 in Google Scholar, and 5 from other sources†. We considered for inclusion 14 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 3 from other sources. Of the 17 articles considered for inclusion, 14 randomized trials and 3 systematic reviews met the inclusion criteria.

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Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ANTICONVULSANTS

Anticonvulsant agents have been utilized off-label for some chronic pain syndromes since the 1960s [571]. They have been particularly used for treating neuropathic pain [572]. Anticonvulsants are thought to have analgesic properties. Several have been used to manage chronic pain conditions include carbamazepine, valproic acid, gabapentin, phenytoin, clonazepam, lamotrigine, tiagabine, pregabalin, topiramate, levetiracetam, oxcarbazepine, and zonisamide.

GABAPENTIN AND PREGABALIN FOR KNEE OSTEOARTHROSIS OR KNEE PAIN

No Recommendation

There is no recommendation for or against the use of gabapentin or pregabalin for treatment of acute, subacute, or chronic knee pain (also see the Chronic Pain guideline).

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Gabapentin has been used for the treatment of knee pain (Du et al., 2022). Gabapentin and pregabalin are most commonly administered orally, have significant adverse effects, but are low cost. However, there is no quality evidence of efficacy for gabapentin or pregabalin for knee pain. Thus, there is no recommendation for or against their use.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: gabapentinoids OR gabapentin OR pregabalin OR gamma aminobutyric acid; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled

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trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 85 articles in PubMed, 7 in CINAHL, 11 in Cochrane Library, 5890 in Google Scholar, and 1 from other sources†. We considered for inclusion 5 from PubMed, 2 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 7 articles considered for inclusion, 4 randomized trials and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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GABAPENTIN FOR PERIOPERATIVE PAIN

Sometimes Recommended

Gabapentin and pregabalin are selectively recommended for perioperative pain management, primarily to reduce opioid consumption. However, because there are other oral regimens and regional blocks that spare opioid use without CNS impairment, the use of gabapentinoids for this purpose is limited to potentially include patients who are at significant risk of opioid misuse, adverse effects, and/or intolerance of other perioperative regimens.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Perioperative pain management, especially among those at risk of opioid misuse and complications and/or who cannot tolerate other regimens of blocks plus medications that are less impairing.

Benefits

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Theoretically improved postoperative pain, reduced need for opioids, fewer opioid-related adverse effects, and potentially faster recovery; however, data mostly suggest inefficacy regarding reduction in pain ratings.

Harms

The main harms are CNS-related: sedation, dizziness, drowsiness, fatigue, ataxia, blurred vision, diplopia, nystagmus. Other potential adverse effects include nausea, vomiting, diarrhea, constipation, dry mouth, edema, weight gain, and headache.

Frequency/Dose/Duration

Limit to immediate perioperative period, usually a few days.

Indications for discontinuation

Completion of the perioperative period, intolerance, adverse effects.

Rationale

Gabapentin has been used for the treatment of perioperative pain (Mao et al., 2016, Zhai et al., 2016, Zhang et al., 2016, Kang et al., 2020, Viderman et al., 2024, Laigaard et al., 2025). Several trials of gabapentin among large joint arthroplasty and back surgery patients report reductions in the need for opioids when administered as part of perioperative pain management (Kheirabadi et al., 2020, Tobias et al., 2020, Khuvtsagaan et al., 2017) (Turan A, 2004, Pandey CK, 2004, Pandey CK, 2005, Khan ZH, 2011, Ozgencil E, 2011) (see Low Back Disorders guideline), although some trials report no reductions in opioid consumption (Lunn et al., 2015). Yet, RCTs reported comparable efficacy for gabapentin with celecoxib (Motififard et al., 2023, Kheirabadi et al., 2020) and duloxetine (Masoumi et al., 2025). Systematic reviews with meta-analyses across numerous types of surgical patients involving 281 trials with 24,682 patients reported lower postoperative pain scores that are below the minimally important difference, lower nausea and vomiting, but higher dizziness and visual disturbance (Tsai SHL, 2023). A meta-analysis of 27 studies with 1,861 spine surgery patients reported a 900-mg dose was optimal for sparing opioids, and postoperative pain ratings were lower with gabapentin (Verret M, 2020). The American Association of Hip and Knee Surgeons guideline concluded similar findings (Hannon et al., 2020).

Thus, because most of the quality evidence suggests opioid sparing but no reduction in pain ratings, while also incurring higher impairment effects, gabapentin and pregabalin in the perioperative phase to spare opioids is selectively recommended for use primarily in those who are unable to tolerate less-impairing regimens and/or are at high risk of adverse effects and/or misuse of opioids.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Gabapentin,

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Perioperative, Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 282 articles in PubMed, 0 in CINAHL, 3 in Cochrane Library, 7,780 in Google Scholar, and 2 from other sources†. We considered for inclusion 2 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 16 from Google Scholar, and 2 from other sources. Of the 18 articles considered for inclusion, 13 randomized trials and 7 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

TUMOR NECROSIS FACTOR-ALPHA BLOCKERS

A variety of tumor necrosis factor (TNF) alpha blockers, including infliximab (a chimeric monoclonal antibody directed against TNF-alpha), etanercept (a recombinant molecule comprising part of the TNF receptor plus the constant region of human immunoglobulin G1 that binds to TNF-alpha) and adalimumab (an IgG1 monoclonal antibody that binds to TNF-alpha) are in widespread use for rheumatologic and other inflammatory disorders. There may be indications for treatment of some patients with these agents in the setting of inflammatory rheumatologic disorders. However, this is beyond the scope of this guideline.

TUMOR NECROSIS FACTOR-ALPHA BLOCKERS FOR KNEE OSTEOARTHROSIS, KNEE PAIN, OR OTHER NONINFLAMMATORY KNEE DISORDERS

Not Recommended

Tumor necrosis factor-alpha blockers are not recommended for the treatment of osteoarthrosis or acute, subacute, or chronic knee pain, including other noninflammatory knee disorders.

Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

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Rationale

A large, placebo-controlled trial suggested lack of efficacy of lutikizimab (Fleischmann et al., 2019). A small RCT evaluated etanercept for treatment of periacetabular osteolysis in arthroplasty patients, but found a lack of efficacy (Schwarz et al., 2003). Two small to modest-sized trials with minimal data reported one intraarticular adalimumab or etanercept injection was superior to hyaluronic acid injection at 4 weeks (Wang et al., 2018, Ohtori et al., 2015). TNF-alpha blockers are minimally invasive, have significant adverse effects, are high cost and have placebo-controlled evidence of a lack of efficacy; thus, they are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: tumor Necrosis factor-alpha blocker, TNF-a blocker, TNF-a inhibitor, osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 188 articles in PubMed, 582 in CINAHL, 24 in Cochrane Library, 5,910 in Google Scholar, and 7 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 4 from other sources. Of the 4 articles considered for inclusion, 2 randomized trials and 2 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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GLUCOSAMINE, CHONDROITIN, AND METHYLSULFONYLMETHANE (MSM)

Glucosamine, chondroitin, and methylsulfonylmethane (MSM) are over-the-counter nutraceuticals [(573)] that have been advocated as safe and effective treatment alternatives to NSAIDs for the management of osteoarthrosis. These supplements have also gained

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additional interest as agents that may potentially modify or slow the progression of osteoarthrosis.

Glucosamine is an amino acid monosaccharide that occurs naturally in the human body, and is one of the principle substrates in the biosynthesis of cartilaginous glycosaminoglycans, proteoglycans, and hyaluronic acid [574]. Although the specific cause of osteoarthrosis is unknown, turnover of the cartilage matrix is mediated by a multitude of complex autocrine and paracrine anabolic and catabolic factors, leading to loss of articular cartilage, subchondral bone remodeling, and low-level inflammation of the synovial membrane [575]. Glucosamine supplementation is hypothesized to beneficially affect the imbalance between rates of synthesis and degradation of cartilage proteoglycans [574,576]. Glucosamine reportedly has anti-inflammatory properties [577,578]. Glucosamine preparations come in two forms, glucosamine sulfate (pill and crystalline powder) or glucosamine hydrochloride [579,580], and are often combined with chondroitin sulfate and sometimes combined with methylsulfonylmethane. Most studies have utilized glucosamine sulfate rather than glucosamine hydrochloride, although there are no quality comparative head-to-head trials. Glucosamine sulfate is also available in suspension for intramuscular and intra-articular injection [581,582,583].

Glucosamine generally has few adverse effects with safety profiles comparable to placebo in the reviewed trials. However, there are two hypothetical risks that may suggest select patient groups to avoid these supplements. First, there is debate as to whether or not glucosamine, which is an aminoglycan, promotes insulin resistance [584,585,586]. However, no adverse effects have been found in patients who have well-controlled diabetes mellitus or even in persons with glucose intolerance [587,588]. Second, glucosamine preparations are commonly produced from the shells of shrimp and crabs (chitin) – seaweed and shark cartilage has also been used [589,590], leading to concerns for potential allergic responses in persons with shellfish allergies. In a trial sponsored by the U.S. National Institutes of Health (NIH) of 15 patients with known systemic allergies to shrimp, administration of glucosamine sulfate was not found to result in any immediate hypersensitivity reactions [591]. Glucosamine products in the U.S. are now also commonly synthesized from grains, providing an alternate source for persons concerned with shellfish allergies. Therefore, these hypothetical risks appear to be low. The most common glucosamine dose is 1500mg per day in single or divided doses.

Chondroitin, a sulfated glycosaminoglycan matrix, provides structural elasticity. Chondroitin is thought to work via anti-inflammatory activity, stimulation of proteoglycans and hyaluronic acid synthesis, and decrease chondrocytic catabolic activity, although the exact mechanisms are unclear [592]. As with glucosamine, there are few reported adverse effects from chondroitin sulfate though some patients have GI tract effects [593]. This supplement is produced from animal cartilage such as bovine trachea, porcine and sharks. The most common dose is 1,200mg per day in single or divided dosages. Chondroitin is most commonly combined with glucosamine in commercial preparations, sometimes additionally including MSM.

GLUCOSAMINE SULFATE, CHONDROITIN SULFATE, OR METHYLSULFONYLMETHANE FOR KNEE OSTEOARTHROSIS

No Recommendation

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There is no recommendation for or against the use of glucosamine sulfate, chondroitin sulfate, and/or methylsulfonylmethane for the treatment of knee osteoarthrosis, primarily due to lack of standardization of dose.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Glucosamine sulfate, chondroitin sulfate, or methylsulfonylmethane have been used for the treatment of knee osteoarthrosis (Kongtharvonskul et al., 2015, Ogata et al., 2018, Baden et al., 2025, Novy et al., 2025). There has been considerable debate over the efficacy of these preparations of glucosamine with and without chondroitin and methylsulfonylmethane in reducing pain, improving function, and slowing the progression of the joint space narrowing in osteoarthrosis. As there is a large body of evidence, this systematic review concentrates on those studies that used objectively measured joint spaces over time to assess efficacy.

Ten quality studies have followed knee joint spaces using either MRI (Railhac et al., 2012, Kwoh et al., 2014, Durmus et al., 2012) or x-rays (Kahan et al., 2009, Michel et al., 2005, Uebelhart et al., 2004, Pavelka et al., 2002, Reginster et al., 2001, Sawitzke et al., 2008, Fransen et al., 2015) to measure the joint space and one has objectively followed the hip joint (Rozendaal et al., 2008). Six trials utilized glucosamine sulfate (Pavelka et al., 2002, Reginster et al., 2001, Sawitzke et al., 2008, Rozendaal et al., 2008, Kwoh et al., 2014, Durmus et al., 2012), four utilized chondroitin sulfate (Kahan et al., 2009, Michel et al., 2005, Uebelhart et al., 2004, Railhac et al., 2012) and one used a combination (Fransen et al., 2015). One of the 3 MRI studies (33% of the studies) suggested improvements in the cartilage on MRI (Railhac et al., 2012), while the only sizable study of the 3 studies using MRI was negative (Kwoh et al., 2014). Overall, six of the x-ray or MRI imaging studies (60% of the studies) demonstrated preservation of joint spaces compared with placebo, including multiple studies reporting either no or reduced joint space narrowing in the active treatment group over 2 years, (Kahan et al., 2009, Michel et al., 2005, Pavelka et al., 2002, Reginster et al., 2001, Fransen et al., 2015) and one reported increased cartilage volume over 2 years (Railhac et al., 2012). Another RCT found the greatest effects were in the group that lost weight (Runhaar et al., 2016, Runhaar et al., 2015). Thus, the studies that utilized x-rays or MRI generally suggested benefits from the treatment of knee osteoarthrosis with either glucosamine sulfate or chondroitin sulfate.

Multiple systematic reviews also concluded there was evidence of joint space preservation with glucosamine and chondroitin (Rabade et al., 2024, Gallagher et al., 2015).

Most of the placebo-controlled studies of glucosamine and/or chondroitin report improvements in pain and/or function (Messier et al., 2007, Hughes et al., 2002, McAlindon et al., 2004, Mehta et al., 2007, Noack et al., 1994, Mazieres et al., 2007, Kahan et al., 2009, Michel et al., 2005, Uebelhart et al., 2004, Clegg et al., 2006, Mazieres et al., 2001, Bucsi et al., 1998, Kerzberg et al., 1987, Bourgeois et al., 1998, Uebelhart et al., 1998)(Bruyère, 2018, Roman-Blas et al., 2017). Few studies assessed MSM and some reported benefits (Usha et al., 2004, Kim et al., 2006)(Toguchi et al., 2023, Tennent et al., 2017).

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Studies compared these treatments with traditional NSAIDs (Sawitzke et al., 2008, Clegg et al., 2006, Muller-Fassbender et al., 1994, Morreale et al., 1996, Lopes Vaz, 1982, Qiu et al., 1998, Cibere et al., 2004) or acetaminophen (Herrero-Beaumont et al., 2007, Marti-Bonmati et al., 2009). Glucosamine hydrochloride, chondroitin sulfate and the combination were not superior to celecoxib 200mg per day or diclofenac 50mg TID (Sawitzke et al., 2008, Clegg et al., 2006, Morreale et al., 1996, Hochberg et al., 2016); however, the combination was successful for treatment of moderate to severe osteoarthrosis compared with placebo (Clegg et al., 2006) and chondroitin sulfate had longer lasting pain relief compared to diclofenac (Morreale et al., 1996). Three studies found glucosamine sulfate comparable to ibuprofen 1200mg per day (Muller-Fassbender et al., 1994, Lopes Vaz, 1982, Qiu et al., 1998). Acetaminophen was found to be inferior to glucosamine sulfate (Herrero-Beaumont et al., 2007).

Glucosamine and chondroitin, alone or in combination, are not invasive, appear relatively safe, do not result in gastrointestinal erosions or the other common side effects of NSAIDS, are relatively low cost (cumulatively may be moderate cost), and may provide some modest relief of knee osteoarthrosis pain, particularly in patients with more advanced pain. A majority of the imaging studies suggest these medications may modify or slow the progression of knee OA as measured by slowing of cartilage destruction and joint narrowing (Sawitzke et al., 2008).

One major limitation of these studies is that different glucosamine formulations (hydrochloride versus sulfate), different frequencies and dosage strengths, and different durations and severities of disease of the study populations are present in different studies (Vlad et al., 2007). The dose is not standardized and reportedly ranges widely in available preparations. There is some evidence that a single daily dose of chondroitin sulfate may be as or more effective than divided doses (Bourgeois et al., 1998). Thus, although there is evidence suggesting potential efficacy with 60% of the imaging-based studies reporting efficacy, and they have very low adverse effect profiles, the lack of standardized dosing prevents the formulation of an evidence-based recommendation in support of these agents. Involving the patient in a discussion for his/her personal decision-making regarding potentially self-administering these over-the-counter agents is advised.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Chondroprotective and glucosamine; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 30 articles in PubMed, 157 in CINAHL, 13 in Cochrane Library, 6,500 in Google Scholar, and 0 from other sources†. We considered for inclusion 4 from PubMed, 1 from CINAHL, 3 from Cochrane Library, 7 from Google Scholar, and 0 from other sources. Of the 15 articles considered for inclusion, 10 randomized trials and 5 systematic reviews met the inclusion criteria.

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Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

HERBAL AND OTHER PREPARATIONS

Many complementary and alternative treatments, including herbal treatments, have been used to treat chronic knee pain, especially pain due to osteoarthrosis [594,595,596,597,598]. These include homeopathic treatments, naturopathic treatments, vitamins, herbal remedies (certain exceptions discussed below), spiritual healing, touch for healing, craniosacral therapy, aromatherapy, energy healing, and neural therapy. Most of these treatments do not have any quality evidence of efficacy [599]. Some controversy surrounds the issue of the value of placebo effects in healing [600]. There are many interventions shown to be efficacious for the treatment of acute, subacute, and/or chronic pain and it is strongly recommended that patients be treated with therapies proven to be efficacious, whether the intervention is considered complementary.

However, there are some remedies which may be efficacious in the management of acute LBP and osteoarthrosis. White willow bark (Salix) extract has been studied in LBP. A principal ingredient is salicin, with salicylic acid as the principal metabolite. Daily doses of 240mg salicin, approximately equivalent to 50mg of acetylsalicylate (which was sufficiently low as to suggest that this may not be the sole reason for its analgesic effect), have been shown to be more effective than placebo in alleviating pain and improving physical impairment scores in patients with acute LBP, with gastrointestinal complaints occurring no more frequently than with placebo. Topical copper salicylates have also been used for treatment of arthrosis [601,602]. Extract of *Harpagophytum procumbens* (devil's claw root) has been used in Europe to treat musculoskeletal symptoms, and there is some evidence that it may relieve acute LBP, acute episodes of chronic LBP, and osteoarthrosis more effectively than placebo in doses that have consisted of the equivalent of 50 to 100mg of harpagoside daily. Mild gastrointestinal upset has been reported at higher doses. Other treatments include ginger extract [603-611], rose hips [612-621], s-adenosylmethionine [622,623,624,625,626,627,628,629,630,631,632], Camphora molmol, Maleluca alternifolia, Angelica sinensis, Aloe vera, Thymus officinalis, Menthe peperita, Arnica Montana [633], Curcuma longa, Tancaetum parthenium, avocado soybean unsaponifiables [573,634-644], oral enzymes [645-650], and others [651-654].

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HERBAL AND OTHER PREPARATIONS (COMPLEMENTARY AND ALTERNATIVE MEDICINE) FOR KNEE PAIN

No Recommendation

There is no recommendation for or against use of willow bark (Salix), ginger extract, rose hips, camphora molmol, maleluca alternifolia, angelica sinensis, aloe vera, thymus officinalis, menthe peperita, arnica montana, curcuma longa, tancaetum parthenium, and zingiber officinicalis, avocado soybean unsaponifiables, oral enzymes, topical copper salicylate, S-Adenosylmethionine, or diacerein harpagoside for treatment of acute, subacute, or chronic knee pain.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Complementary or alternative treatments including dietary supplements has been used for the treatment of knee pain (Garcia-Coronado et al., 2019, Honvo et al., 2019, Liu et al., 2019, Aghmohammadi et al., 2020, Deng et al., 2023, Moyseos et al., 2024, Chen et al., 2025, & Zhang et al., 2025). Most of these agents have no quality evidence available (e.g., Camphora molmol, Maleluca alternifolia, Angelica sinensis, Aloe vera, Thymus officinalis, Menthe peperita, Arnica Montana, Curcuma longa, Tancaetum parthenium, Harpagoside) for acute, subacute, or chronic knee pain. Some have conflicting results, e.g., willow bark (Salix) (Biegert et al., 2004, Schmid et al., 2001), rose hips, avocado soybean unsaponifiables, and ginger extract. Still others have no quality studies comparing the active ingredient with placebo (e.g., S-Adenosylmethionine, harpagoside, oral enzymes), and one agent appears ineffective (copper salicylate).

None of these agents has had a standardized dose, resulting in a lack of clarity of patient dosing. All of the studies comparing the agent to a standard NSAID dose found the NSAID superior. Only those studies with lower doses of NSAIDs found evidence suggesting equivalency (see herbal and other preparations evidence table). These agents are not invasive, have unclear adverse effect profiles, and over time are moderate to highly costly. There is no recommendation for or against use of these agents.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: "Phytotherapy; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 13 articles in PubMed, 70 in CINAHL, 9 in Cochrane Library, 17,500 in Google Scholar, and 0 from other sources†. We considered for inclusion 1 from PubMed, 2 from CINAHL, 3 from Cochrane Library, 14 from Google Scholar, and 0 from other sources. Of the 20 articles

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considered for inclusion, 10 randomized trials and 10 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

DIACEREIN

Diacerein is an alternative pharmaceutical therapy developed for the treatment of osteoarthrosis and purported to have inhibitory action on interleukin-1, metalloproteases and other inflammatory mediators involved in cartilage destruction in in vivo and animal models, including of inflammatory arthropathies [655-663]. It also stimulates prostaglandin E_2 synthesis without affecting phospholipase A_2, cyclooxygenase (COX), or lipoxygenase, and thus does not affect the gastric mucosa [664]. Diacerein has been used as a disease modifying agent in patients with moderately progressive joint narrowing [665,666,667,668]. It is available by prescription in only a few countries in Asia and Europe, and it is not currently available in the U.S. The adverse effect profile is generally significantly higher than placebo, mostly due to higher incidence of diarrhea [656,661] and darkening of the urine, and the magnitude of its effects on pain are small [658]. Diacerein is not widely available and may not be a treatment option for most patients. Optimal dose has been suggested to be 50mg twice daily [661]. It may be an alternative to NSAIDs as a second- or third-line treatment, particularly for patients with a history of upper gastrointestinal bleeding, as it appears to be potentially associated with lower rates of gastric lesions [664]. However, one quality study suggests NSAIDs are superior to diacerein for relief of pain [669]. There are a few quality studies of diacerein in knee or combinations of hip and knee osteoarthrosis patients in this analysis [661,670-679].

DIACEREIN FOR KNEE OSTEOARTHROSIS

Not Recommended

Diacerein is not recommended for the treatment of knee osteoarthrosis.

Strength of evidence Not Recommended, Insufficient Evidence (I)

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Level of confidence Low

Rationale

Diacerein is not FDA-approved for any indication.

Diacerein has been used for the treatment of knee osteoarthrosis (Kongtharvonskul et al., 2015, Honvo et al., 2019, Honvo et al., 2025). Of the eight high- or moderate-quality studies evaluating diacerein, all five that compared it against placebo demonstrated modest pain relief from diacerein (Pelletier et al., 2000, Dougados et al., 2001, Pavelka et al., 2007). A study to establish dose-response showed statistically significant improvement of symptoms with a 50-, 100-, and 150-mg daily dose, but with fewest side effects and best efficacy with the 100-mg per day group (Pelletier et al., 2000), while another trial found 100 mg does better than 50 mg (Phan et al., 2025). There is evidence suggesting that the effects of diacerein last weeks to months after cessation of therapy (Nguyen et al., 1994, Pavelka et al., 2007), which is not the case for NSAIDs (Nguyen et al., 1994). In addition to the symptomatic relief reported, there is one high-quality study of the hip that demonstrated a significant difference in joint space narrowing versus placebo (Dougados et al., 2001). A 2x2 factorial study of the hip comparing diacerein, tenoxicam, diacerein, with tenoxicam and placebo demonstrated early efficacy of tenoxicam. However, after 4 weeks, the diacerein plus placebo group also reached statistically significantly better symptomatic relief than placebo alone (Nguyen et al., 1994). There was no added synergistic effect; diacerein plus tenoxicam was no better or worse than each alone. A trial found glucosamine added to diacerein was not superior to diacerein alone (Kongtharvonskul et al., 2016). One trial found equivalency with celecoxib 200 mg QD (Pelletier et al., 2020), while another found additive benefit with celecoxib (Youn et al., 2023).

Examination of diacerein efficacy in two studies that used diacerein as one of the control arms rather than the main active research arm were not as conclusively in favor of diacerein. A comparison of diacerein to hyaluronic acid intra-articular injections over 1 year did not demonstrate diacerein to be more effective than an oral placebo, but the study had significant methodological weaknesses including a possible placebo effect of intra-articular injection masking the effect of oral diacerein treatment (Pham et al., 2004). Two studies comparing diacerein to Harpagophytum procumbens (Devil's Claw Root) demonstrated both to be effective in improving pain and functional scores over baseline, but there was no placebo group for comparison (Chantre et al., 2000, Leblan et al., 2000).

Because diacerein is not approved for any indication in the United States, it is not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Diacerein; Knee osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic,

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systematic review, retrospective, and prospective studies. We found and reviewed 19 articles in PubMed, 10 in CINAHL, 15 in Cochrane Library, 881 in Google Scholar, and 0 from other sources†. We considered for inclusion 10 from PubMed, 2 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 12 articles considered for inclusion, 6 randomized trials and 6 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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VITAMINS

VITAMIN D FOR KNEE OSTEOARTHROSIS

Not Recommended

Vitamin D is not recommended for treatment of knee osteoarthrosis. There are other indications for vitamin D.

Strength of evidence Moderately Not Recommended, Evidence (B)
Level of confidence Low

Rationale

Vitamin D has been used for the treatment of knee osteoarthrosis (Cao et al., 2013, Zhu et al., 2014, Diao et al., 2017, Gao et al., 2017, Hussain et al., 2017, Zi-Xia et al., 2021, Wang et al., 2023). Epidemiological reports of associations between low vitamin D levels and knee arthritis progression (McAlindon et al., 1996, Zhang et al., 2014) formed the basis for using vitamin D for the potential prevention of osteoarthrosis progression. There are multiple quality trials of vitamin D for treatment of knee OA that measured joint space narrowing or cartilage volume and all showed lack of efficacy (Jin et al., 2016, Arden et al., 2016, McAlindon et al., 2013). One moderate-quality study suggested a small reduction in pain with vitamin D, but did not measure the joint spaces (Sanghi et al., 2013). Vitamin D is not

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invasive, has few adverse effects, and is low cost. However, due to the lack of efficacy in the evidence, it is not recommended. There are other indications for use of vitamin D.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Vitamin D; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 80 articles in PubMed, 15 in CINAHL, 59 in Cochrane Library, 18,500 in Google Scholar, and 6 from other sources†. We considered for inclusion 14 from PubMed, 1 from CINAHL, 1 from Cochrane Library, 10 from Google Scholar, and 6 from other sources. Of the 32 articles considered for inclusion, 25 randomized trials and 7 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

COLLAGEN

COLLAGEN (HYDROLYZED AND NONHYDROLYZED) FOR KNEE OSTEOARTHROSIS

No Recommendation

There is no recommendation for or against hydrolyzed or nonhydrolyzed collagen for the treatment of knee osteoarthrosis.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

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Hydrolyzed or non-hydrolyzed collagen has been used for the treatment of knee osteoarthrosis (Van Vijven et al., 2012, García-Coronado et al., 2019, Sadigursky et al., 2023, Simental-Mendía et al., 2025). There are few studies of hydrolyzed collagen for treatment of knee OA, however they used different products. In contrast with glucosamine, there are no trials that measured joint space on radiographs. One trial used native type II collagen, and reported superiority to placebo and equivalency to glucosamine (Luo et al., 2022). Another trial used undenatured collagen and reported superiority to placebo (Schön et al., 2022). Another trial using undenatured collagen and reported superiority to glucosamine (Lugo et al., 2016). One trial of a combination of undenatured and hydrolyzed collagen reported superiority to placebo (Yuenyongviwat et al., 2025). Meta-analyses have combined the studies to suggest there is benefit (García-Coronado et al., 2019, Sadigursky et al., 2023, Simental-Mendía et al., 2025). Thus, while there is some preliminary evidence suggesting there may be some potential efficacy, the administration is oral, has few adverse effects and is cumulatively moderate cost, but the sparse data with different products result in no recommendation for or against any of these products.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Collagen; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 262 articles in PubMed, 1202 in CINAHL, 13 in Cochrane Library, 85,400 in Google Scholar, and 0 from other sources†. We considered for inclusion 5 from PubMed, 1 from CINAHL, 1 from Cochrane Library, 3 from Google Scholar, and 0 from other sources. Of the 10 articles considered for inclusion, 6 randomized trials and 4 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

DEVICES

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OVERVIEW

Some patients with knee pain might benefit from limited use of devices, particularly as an assistive aid while improved or full function is sought. These aids include crutches, walkers, canes, motorized scooters, heel wedges and insoles, and functional braces [293-302,680-684]. However, aids might also be detrimental, as they may discourage therapeutic physical activity. In general, a device is recommended when it is either part of a plan to regain better or normal function or it is essential to achieve the maximum function possible within the limits of fixed defects (see diagnostic sections for devices used for specific disorders).

KNEE BRACES

Knee bracing has been used for some cases of knee osteoarthrosis [685,686]. Braces include unloader or off-loader braces designed to reduce force on one tibiofemoral compartment [687-694]. Most commonly, an "off-loader" brace has been utilized to attempt to reduce force on the medial compartment in cases of medial or largely medial joint OA. They also have been utilized to prevent sports injuries, especially in football athletes [695-700], although there are concerns that the use of a brace leads to reduced performance [699]. Knee sleeves and other appliances have also been utilized.

OFF-LOADER BRACES FOR KNEE OSTEOARTHROSIS

Sometimes Recommended

Off-loader braces are recommended for treatment of select patients with medial joint osteoarthrosis.

Strength of evidence Recommended, Evidence (C)
Level of confidence Low

Indications

Patients should generally have attempted other non-operative treatments, including NSAIDs, analgesics, weight loss, and exercises. Additionally, patients must be highly motivated to be compliant with the device.

Rationale

Off-loader braces have been used for the treatment of knee osteoarthrosis (Gohal et al., 2018). There are several moderate-quality trials that have addressed bracing for unicompartmental osteoarthrosis. One trial compared lateral wedges to knee braces and found comparable results (van Raaij, 2010), while large numbers of trials of lateral wedges have found a lack of efficacy (see separate recommendation). Two trials comparing bracing with no bracing or usual care found bracing to be modestly superior (Kirkley et al., 1999, Draganich et al., 2006), although the Kirkley trial had baseline differences rendering interpretation difficult. Another trial comparing bracing with usual care and usual-care-only found bracing to be of little benefit (Brouwer et al., 2006), while another similarly designed study found modest benefit (Thoumie et al., 2018). One trial suggested bracing to be superior to neoprene sleeves (Kirkley et al., 1999). Another crossover trial suggested a valgus brace was superior to a simple hinged brace (Richards et al., 2005). One trial found

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comparable (in)efficacy comparing an off loader brace with an ankle-foot brace (Petersen et al., 2019). A Cochrane review deemed the overall evidence base was low, and concluded that wearing a brace compared to no brace resulted in little or no differences in pain reduction, knee function, and/or quality of life; as well, they concluded there was comparable inefficacy for lateral wedged insoles (Duivenvoorden et al., 2015). Another systematic review with meta-analysis drew similar conclusions supporting a lack of statistically significant impacts on pain or function (Fan et al., 2020).

Braces (including off-loader braces) are not invasive, have low adverse effects, but are moderate to high cost. They have considerable problems with compliance. Thus, they are not recommended. There may be highly select indications for individuals who are highly motivated, have moderate to severe largely unicompartmental osteoarthrosis, and are not good candidates for arthroplasty.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Braces, off-loading braces, off-loader braces; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 163 articles in PubMed, 67 in CINAHL, 38 in Cochrane Library, 28,500 in Google Scholar, and 0 from other sources†. We considered for inclusion 4 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 6 from Google Scholar, and 0 from other sources. Of the 10 articles considered for inclusion, 7 randomized trials and 3 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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POSTOPERATIVE BRACES FOR KNEE ARTHROPLASTY

Not Recommended

Postoperative knee braces are moderately not recommended after knee arthroplasty.

Strength of evidence Moderately Not Recommended, Evidence (B)
Level of confidence Low

Rationale

Braces and splints have been remotely used post-operatively after arthroplasty. Two moderate-quality trials both suggested a lack of benefit from post-arthroplasty bracing (Zenios et al., 2002, Horton et al., 2002). Further, successful recent components, operative approaches and rehabilitation protocols now facilitate early, immediate post-operative ambulation without braces and splints that then progress. Therefore, braces and splints may potentially hinder rehabilitation and thus, post-operative bracing or splints are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: post operative braces, postoperative knee braces; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 15 articles in PubMed, 2 in CINAHL, 4 in Cochrane Library, 1700 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trial and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

KNEE SLEEVES

SLEEVES FOR KNEE OSTEOARTHROSIS

Not Recommended

Sleeves are moderately not recommended for the treatment of knee osteoarthrosis.

Strength of evidence Moderately Not Recommended, Evidence (B)
Level of confidence Low

Rationale

Knee sleeves have been evaluated in moderate-quality trials and have not been found to produce clinically meaningful benefits for treatment of knee OA (Kirkley et al., 1999, Pajareya et al., 2003, Chuang et al., 2007). One trial of two knee sleeves found comparable (in)efficacy (Ortanca, 2025). Thus, the quality trials suggest a lack of efficacy and knee sleeves are not recommended.

Knee sleeves and braces are occasionally used for treatment of acute knee sprains. However, there are no quality trials to address their utility.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: knee sleeves, sleeves; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 60 articles in PubMed, 9 in CINAHL, 6 in Cochrane Library, 8,210 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 0 from other sources. Of the 2 articles considered for inclusion, 2 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

ORTHOTICS

Orthoses have been used for treatment of knee osteoarthrosis [681-683,701-715]. Foot orthotics, most commonly lateral wedges, have been used to attempt to redirect force from the medial compartment to the lateral compartment in patients with primarily medial compartment disease [701,716,717].

LATERAL WEDGES FOR KNEE OSTEOARTHROSIS

Not Recommended

Lateral wedges are not recommended for treatment of medial compartment knee osteoarthrosis.

Strength of evidence Moderately Not Recommended, Evidence (B)
Level of confidence Low

Rationale

Lateral wedges have been used for the treatment of knee osteoarthrosis (Arnold et al., 2016, Xing et al., 2017, Ferreira et al., 2018, Shaw et al., 2018, Zhang et al., 2018, Yu et al., 2021). Lateral wedging (whether wedges or orthoses) have been evaluated in many moderate quality trials, with one trial having attempted blinding of shoes with wedges and suggested no differences with lateral wedging (Barrios et al., 2009), and additional trials also suggesting lack of efficacy (Maillefert et al., 2001, Hinman et al., 2009, Baker et al., 2007, Hsieh et al., 2016, Bennell et al., 2011, Barrios et al., 2009, Lewinson et al., 2016, Felson et al., 2019, Campos et al., 2015, Pham et al., 2004). One trial compared lateral wedges to knee braces and found comparable results (van Raaij, 2010), while other trials found comparable (in)effective results between a lateral wedge insole and a biaxial ankle-foot orthosis (Barati et al., 2022, Schwarze et al., 2021). A Cochrane review concluded there were probably no differences in pain, function, stiffness or quality of life resulting from wedges or wedged insoles (Duivenvoorden et al., 2015). Another systematic review also found similar results and concluded there was a lack of efficacy (Parkes MJ, 2013). Thus, as the quality trials consistently suggest a lack of efficacy, lateral wedges are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: lateral wedges OR lateral wedge insole; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain,

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chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 378 articles in PubMed, 45 in CINAHL, 21 in Cochrane Library, in 17,300 Google Scholar, and 6 from other sources†. We considered for inclusion 7 from PubMed, 0 from CINAHL, 4 from Cochrane Library, 26 from Google Scholar, and 0 from other sources. Of the 37 articles considered for inclusion, 31 randomized trials and 6 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

CANES AND CRUTCHES

CANES AND CRUTCHES FOR KNEE PAIN

Recommended

Canes and crutches are selectively recommended for treatment of moderate to severe acute knee pain or subacute and chronic knee pain when the device is used to advance the activity level.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Moderate to severe acute knee pain or subacute or chronic knee pain, particularly when the device is utilized to increase activity level.

Rationale

Crutches and canes may be helpful for treating acute injuries during the recovery phase. They also may be helpful during the rehabilitative phase to increase functional status (e.g., from wheelchair to walker to cane). However, for chronic knee pain, crutches may

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paradoxically increase disability through debility. In those circumstances, institution or maintenance of advice for crutch or cane use should be carefully considered against potential risks.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: canes, crutches, osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 11 articles in PubMed, 17 in CINAHL, 0 in Cochrane Library, 17,200 in Google Scholar, and 0 from other sources†. We considered for inclusion 1 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trial and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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MOTORIZED SCOOTERS

Motorized scooters have been used for treatment of severe knee arthrosis [718].

MOTORIZED SCOOTERS FOR KNEE OSTEOARTHROSIS

Sometimes Recommended
Motorized scooters are selectively recommended for patients who have severe chronic knee pain due to osteoarthrosis and are generally not surgical candidates.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

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Indications

Severe chronic knee osteoarthrosis accompanied by major impairment in mobility that has either not responded well to arthroplasty and/or other significant impairments are present that necessitate use of a motorized scooter. Patients should also have had inadequate response to multiple other treatments including at least 2 different NSAIDs, aerobic exercise, strengthening exercise, weight loss, and aquatic therapy program. Patients should generally be ineligible for arthroplasty, as motorized scooters are generally counter-productive by increasing debility in the pre-arthroplasty setting where instead, exercises and potentially prehab are indicated.

Rationale

There is one moderate-quality trial of intermittent motorized scooter use in knee osteoarthrosis patients (Hoenig et al., 2007). The trial reported no meaningful increases in manual activity and long-term effects, including deconditioning, are unclear. Scooters are costly; thus, they are recommended for highly select use generally for those with either inability to undergo arthroplasty or who sustained a major operative failure(s) with resultant surgical ineligibility or permanent complications.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: motorized mobility scooter, scooter, osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 110 articles in PubMed, 0 in CINAHL, 0 in Cochrane Library, 252 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria. Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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MAGNETS AND MAGNETIC STIMULATION

High-intensity magnetic stimulation purportedly causes depolarization of nerves and has been found to result in an antinociceptive effect in rats [719,720]. Electromagnetic fields have also been reported to increase osteoblastic activity [721]. Therefore, proponents of magnet therapy believe that magnetic fields have value in the treatment of musculoskeletal disorders. Many studies of magnet therapy have been negative, although several studies have reported benefits [722,723]. Magnets have been studied in rheumatoid arthritis [724], which is beyond the scope of this guideline.

MAGNETS AND MAGNETIC STIMULATION FOR KNEE OSTEOARTHROSIS AND KNEE PAIN

Not Recommended

Magnets and magnetic stimulation are not recommended for treatment of osteoarthrosis or acute, subacute and chronic knee pain.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

There are quality sham-controlled trials that evaluate the use magnets for treatment of knee osteoarthrosis. However, it cannot be assumed that subjects in these trials were successfully blinded (Wolsko et al., 2004, Harlow et al., 2004, Chen et al., 2008, Jacobson et al., 2001, Hinman et al., 2002). One trial reported that most of the subjects accidentally or purposefully were unblinded to the intervention (Wolsko et al., 2004), and other trials did not report on the success of blinding. One sham-controlled trial reported lack of efficacy of peripheral magnetic stimulation (Keesukphan et al., 2023). Therefore, the evidence base is limited and conflicting. Another trial that included a sham control (active magnets that were shielded from the skin) did not find meaningful outcomes at follow-up (Wolsko et al., 2003). A four-arm trial showed lack of efficacy in all three active treatment arms, including pulsed electromagnetic fields plus exercise compared with the control of health education plus exercise (Wang, 2026).

There is no consistent evidence base suggesting either magnets or magnetic stimulation are effective. These treatments are not invasive and have no adverse effects, range from low cost (magnetic devices) to high cost (rTMS) and in the absence of quality evidence of intermediate- or long-term efficacy and other treatments with proven efficacy, thus these treatments are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: magnetic stimulation, magnetics; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found

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and reviewed 3402 articles in PubMed, 1068 in CINAHL, 30 in Cochrane Library, 18600 in Google Scholar, and 0 from other sources†. We considered for inclusion 3 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 6 from Google Scholar, and 0 from other sources. Of the 9 articles considered for inclusion, 9 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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PULSED ELECTROMAGNETIC FIELDS FOR KNEE OSTEOARTHROSIS AND KNEE PAIN

Not Recommended

Pulsed electromagnetic fields are not recommended for the treatment of knee osteoarthrosis or acute, subacute, or chronic knee pain.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Pulsed electromagnetic fields have been used for the treatment of knee osteoarthrosis and knee pain (Zeng et al., 2015, Chen et al., 2019, Viganò et al., 2021, Markovic et al., 2022, Tong et al., 2022, Cianni et al., 2024). Sham-controlled trials have shown lack of efficacy for PEMF (Ay et al., 2009, Dündar et al., 2016). There are multiple other trials of magnetic fields and the evidence substantially conflicts regarding efficacy (Trock et al., 1994, Thamsborg et al., 2005, Gremion et al., 2009, Zizic et al., 1995, Pipitone et al., 2001). One trial for knee OA suggested benefits in VAS and WOMAC scores (Bagnato et al., 2015). A moderate-quality study using PEMF after ACL reconstruction found significant recovery compared to placebo (Benazzo et al., 2008). A low-quality study evaluated PEMF after arthroscopic surgery and reported improved recovery at 3 years and decreased NSAID use 45 days post-operatively (Zorzi et al., 2007); these results require replication in a sizable study. A trial reported minimal differences of questionable clinical significance (Wang et al., 2024).

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There are many low-quality trials and excluded studies with problems including small sample sizes, significant differences in baseline data, lack of CONSORT diagrams and other methodological weaknesses (Trock et al., 1993, Pasin et al., 2025, Elboim-Gabyzon et al., 2023, Battecha et al., 2015, Xu et al., 2024, Dündar et al., 2016, Maghroori et al., 2025, Wang et al., 2024, Yabroudi et al., 2024, TERZİ et al., 2017, Külcü et al., 2009, Nelson et al., 2013, Servodio Iammarrone et al., 2016, Gomes Gobbi et al., 2019, Zorzi et al., 2007). A systematic review concluded PEMF is not effective for pain or stiffness but is helpful for physical function (Viganò et al., 2021).

Pulsed electromagnetic field treatments are not invasive and have no adverse effects. However, they are cumulatively moderately costly and multiple studies (especially sham-controlled studies) have suggested no benefit. Thus, PEMF is not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Electromagnetic Fields; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 8 articles in PubMed, 6 in CINAHL, 0 in Cochrane Library, 17,800 in Google Scholar, and 2 from other sources†. We considered for inclusion 3 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 2 from other sources. Of the 7 articles considered for inclusion, 1 randomized trials and 6 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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HOT AND COLD THERAPIES

It has been proposed that cold and heat have actual therapeutic benefits to modify the disease processes (e.g., cold to allegedly reduce acute inflammation and swelling and heat to speed healing through increased blood supply) [725,726]. However, it has been proposed that these various modalities are distractants that apparently do not materially alter the clinical course [727]. Still, it is postulated that the distractants allow increased activity levels [728]. Many patients with chronic pain report a temporary soothing effect from the application of heat or the use of ice packs in the home setting. Cryotherapies have also been utilized in perioperative and postoperative patients to speed healing and attempt to reduce opioids requirements [729-738].

CRYOTHERAPY

Cold or cryotherapies involve application of cold or cooling devices to the skin. They have been used for treatment of nonoperative pain and postoperative pain [739].

CRYOTHERAPIES FOR OSTEOARTHROSIS OR KNEE PAIN

Recommended

Cryotherapies are recommended for at-home use for the temporary relief of knee pain, especially after acute injuries, but may also be used to treat osteoarthritic knee pain.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Generally thought to be more successful for acute injuries rather than for chronic conditions such as knee OA.

Benefits

Theoretically reduced pain, swelling and need for medication, especially in acute injuries.

Harms

Negligible unless the cold application is excessively prolonged or cold/freezes the skin.

Frequency/Dose/Duration

Typical uses are 15-20 minutes 3-5 times a day as needed.

Indications for discontinuation

Non-tolerance, including exacerbation of knee pain.

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Rationale

Home use of cryotherapies have been used for the treatment of knee osteoarthrosis or knee pain (Dantas et al., 2019, Dias et al., 2025). There are few RCTs of cryotherapy for non-arthroplasty knee pain patients, none of high quality, and none rigorously testing its utility. One trial comparing of heat vs. cryotherapy for knee OA found comparable (in)efficacy (Aciksoz et al., 2017). One trial with cryotherapy therapy used in both arms plus either manual therapy or kinesiotherapy (i.e., stretching and strengthening) found the arm with manual therapy modestly superior for pain and function; however study details involving exercises render the results difficult to interpret (Lizis et al., 2019). A trial comparing 4 consecutive days of treatments of bags of crushed ice with sandbags found lack of efficacy (Dantas et al., 2019). A low-quality study suggested results of an exercise program were better when combined with cryotherapy for treatment of knee OA (MohammedSadiq et al., 2023). One systematic review similarly found insufficient evidence to conclude efficacy regarding treatment of knee OA (Dantas et al., 2019), while another found limited supportive evidence (Dias et al., 2025).

It is noteworthy that there is an absence of quality evidence addressing common knee pain-related uses of cryotherapy such as acute sprains and strains. The limited evidence base is centered on knee OA, and even for that indication, is quite sparse. Self applications of cryotherapies using ice bags, cold towels or reusable devices are non-invasive, have low adverse effects, are low cost and thus are recommended especially for acute injury management. While cryotherapy is generally not significantly helpful for osteoarthrosis, a small minority may find benefit and thus, cryotherapy is recommended as a potential distractant or counter-irritant for knee OA patients.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Cryotherapy, cold therapy, cold water immersion, ice baths; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 134 articles in PubMed, 29 in CINAHL, 15 in Cochrane Library, 18,200 in Google Scholar, and 7 from other sources†. We considered for inclusion 8 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 8 articles considered for inclusion, 6 randomized trials and 2 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full

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evidence base used in this guideline includes all relevant studies identified without date constraints.

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CRYOTHERAPY AFTER KNEE ARTHROPLASTY, ARTHROSCOPY, OR OTHER SURGERIES

Recommended

Cryotherapy is recommended for treatment after knee arthroplasty and or other knee surgeries.

Strength of evidence Recommended, Evidence (C)
Level of confidence Low

Indications

Cryotherapy is recommended for treatment of patients after arthroplasty and other knee surgeries.

Benefits

May reduce pain, opioids consumption and help with self-management of pain. May reduce blood loss, swelling and range of motion (Aggarwal et al., 2023).

Harms

Negligible unless use is overly prolonged or treatment progresses to freezing the skin.

Frequency/Dose/Duration

Pain relief with cold therapy for the first several post-operative days with duration commensurate with extent of surgery. and pain. Some devices such as "ice machines" may be helpful for select patients, particularly for more extensive surgeries such as arthroplasty.

Indications for discontinuation

Sufficient recovery to obviate need for cryotherapy, non-tolerance, adverse effects.

Rationale

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Cryotherapy has been used for the treatment of knee arthroplasty (Aggarwal et al., 2023, Lee et al., 2023, Liu et al., 2022). There are many postoperative studies, although few are moderate quality and most have significant methodological limitations. One moderate-quality trial of computer-assisted cryotherapy after outpatient TKA found cryotherapy (10-12 °C) superior to warm water (21 °C), largely based on the warm water group using 77% more milligrams of the rescue medication tramadol (Thijs et al., 2019). Another trial of hospitalized TKA patients found superiority of a computer-controlled cooling device compared to cold packs for earlier mobilization, ROM and pain (Sadoghi et al., 2018). One trial of the additive benefits of a computer-assisted cryotherapy device added to usual care reported improvements in pain control, reduced opioids consumption (109% more MED/mg of oxycodone in the control group) and trends towards better measures of function (Brouwers et al., 2022), although there were no statistically significant benefits at 1 year (Teeuw et al., 2025). A trial of postoperative cryocompression vs. both pre- and postoperative cryo-compression found mostly nonsignificant differences over 20 days of follow-up, although the range-of-motion and rehabilitation milestones were reached earlier in the intervention group (Pieri et al., 2025).

Most of the older studies also used intra-hospital cryotherapy and reported no clear intra-hospital benefits (Konrath et al., 1996, Ivey, 1994, Smith et al., 2002), although one more recent study reported patient satisfaction was best with cryotherapy (Chareancholvanich et al., 2025). Hospitalized studies may no longer be applicable in the United States because operative techniques are more advanced and, importantly, the vast majority of patients are now managed as outpatients; thus, RCT evaluations of self-applications of cryotherapy at home are critical to assess efficacy and there are few such studies. One trial suggested no benefit (one compared cold therapy with lukewarm water (Konrath et al., 1996)) and one suggesting benefits, including opioid sparing (compared cold therapy with traditional post-operative regimens not including epidural anesthesia (Holmstrom et al., 2005)). Reported impacts on blood loss and swelling appear negligible.

There are many low quality RCTs. One small, attempted sham trial found better pain and ROM results in the cryo plus exercise group than the sham plus exercise groups (Lee et al., 2024). One comparative study of an ice machine vs. gel packs found comparable efficacy (Schinsky et al., 2016). One small trial found compression added to cryotherapy to be superior to cryotherapy (Quesnot et al., 2024). One low quality study concluded kinesiotaping was superior, however it appears to have suffered a randomization failure with differences in multiple baseline data (Yuksel, 2021).

A Cochrane review concluded the evidence was of low quality, with some evidence of blood loss, pain and range of motion although the benefits "may be small" (Aggarwal et al., 2023).

Cryotherapy after arthroplasty has consistent evidence of efficacy in the higher quality studies, especially those using "ice machines." Results include improved pain, 43-52% reductions in opioids consumption, and earlier improvements in ROM (Thijs et al., 2019, Sadoghi et al., 2018, Brouwers et al., 2022, Teeuw et al., 2025). Thus, while use of a machine is moderately costly, data support either self-applications of ice/gel packs and/or use of an "ice machine" for postoperative patients, especially those with more extensive surgical procedures such as arthroplasty (Holmstrom et al., 2005).

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Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: cryotherapy, ice machine, cold therapy, osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 163 articles in PubMed, 29 in CINAHL, 17 in Cochrane Library, 17400 in Google Scholar, and 0 from other sources†. We considered for inclusion 7 from PubMed, _1 from CINAHL, 0 from Cochrane Library, 6 from Google Scholar, and 0 from other sources. Of the 14 articles considered for inclusion, 9 randomized trials and 5 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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HEAT THERAPY

Many forms of heat therapy have been used to treat musculoskeletal pain including hot packs, moist hot packs, sauna, warm baths, infrared, diathermy, and ultrasound. The depth of penetration of some heating agents is minimal since transmission is via conduction or convection, but other modalities have deeper penetration [(740)]. A particular methodological problem with most studies of heat therapy is that, despite occasional attempts at, and claims of, successful blinding, it is impossible to blind the patient to these interventions, as they produce noticeable, perceptible tissue warming. Not surprisingly, some of these heat-related modalities have been shown to reduce pain ratings more than placebo for patients with low back pain. It is less clear whether there are meaningful, long-term benefits. Heat therapies are passive treatments. In chronic pain settings, use of heat should be minimized to self-treatments of flare-ups with primary emphasis on functional restoration elements (e.g., exercises). There are many commercial modalities that deliver heat; these generally differ on how deeply the heat is felt. None of these modalities have demonstrated major efficacy for any disorder, however there have been limited uses for treatment of specific

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disorders with a specific intervention (see Hand, Wrist, and Forearm Disorders, Elbow Disorders, Low Back Disorders, and Chronic Pain guidelines). There are more trials that include ultrasound to treat the knee than the hip [(741)]

SELF-APPLICATION OF HEAT THERAPY FOR OSTEOARTHROSIS OR KNEE PAIN

Recommended

Self-application of low-tech heat therapy is recommended for treatment of osteoarthrosis or acute, subacute, or chronic knee pain.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Applications may be periodic and should be home-based, as there is no quality evidence for efficacy of clinician-based heat treatments. Primary emphases should generally be on functional restoration program elements, rather than on passive treatments in patients with chronic pain.

Frequency/Dose/Duration

Self-applications may be periodic. Education regarding home heat application should be part of the treatment plan if heat has been effective for reducing pain.

Indications for discontinuation

Intolerance, increased pain, development of a burn, other adverse event.

Rationale

There are few trials of heat therapy for knee conditions. One trial compared a heated sleeve vs. a placebo sleeve and failed to find differences for treatment of knee OA (Mazzuca, 2004). A comparative trial between heat, cold and control found a lack of differences for treatment of knee OA (Aciksoz et al., 2017). One trial of a heat gun at non-joint line acupressure points reported slight differences of questionable clinical significance in a couple measures compared with traditional hot pack treatments (Ho et al., 2021). A low-quality trial compared heat and cold as an adjunctive treatment for stretching after prior, initial treatment with heat and found cold to be modestly superior although the study weaknesses including baseline differences render interpretation difficult (Lin, 2003). While the evidence suggests heat therapy is not successful for the treatment of knee OA, self-applications of non-commercial products have no cost and may be helpful in a small minority as a potential distractant or counter-irritant. Commercial products, machines, and office-based applications are not proven and are not recommended.

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: induced hyperthermia, Heat therapy, hyperthermia therapy; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 11 articles in PubMed, 4 in CINAHL, 37 in Cochrane Library, 17,900 in Google Scholar, and 0 from other sources†. We considered for inclusion 2 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 0 from other sources. Of the 4 articles considered for inclusion, 4 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ALLIED HEALTH INTERVENTIONS

MANUAL THERAPY

Massage is a commonly used treatment for chronic muscular pain and usually administered by multiple clinicians as well as family or friends. It is most typically used for treatment of spine and torso pain (see Chronic Pain and Low Back Disorders guidelines), although it has been used for the treatment of knee pain [742,743].

Manipulation and mobilization are two other types of manual therapy, with manipulation involving greater force at higher velocities and mobilization involving lower force at low velocities. Mobilization has not been assessed in quality RCTs to determine its efficacy. Manipulation has been used in quality trials to treat knee disorders, particularly for postoperative patients who have inadequate range of motion that affects function (sometimes called *arthrofibrosis*) [744,745,746,747,748].

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MASSAGE FOR KNEE OSTEOARTHROSIS OR KNEE PAIN

Not Recommended

Massage is not recommended for treatment of knee osteoarthrosis or acute, subacute, or chronic knee pain.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Massage has been used for the treatment of knee pain (Wang et al., 2022, Wu et al., 2022). There are few quality studies, no sham-controlled RCTs, and no studies showing durable benefits. Two trials suggested short-term, but not long-term modest benefits but the comparisons were non-interventional controls (Yip et al., 2008, Nasiri et al., 2016). A crossover trial used a comparator of health education and suggested minor benefits; however, that trial likely did not use a plausible sham/equivalent-control (Liu et al., 2023). There are a plethora of low-quality trials of small sample sizes, missing CONSORT diagrams, missing baseline data, failure to report outcomes data by group assignments, and/or appearing to have randomization failures or other potentially fatal flaws (Ali et al., 2017, Aryanti et al., 2018, Bai et al., 2025, Bakir et al., 2026, Doner, 2024, El Sayed et al., 2020, Esfahani et al., 2020, Hasanpour-Dehkordi et al., 2021, Islam et al., 2021, Kabiri et al., 2018, Pehlivan et al., 2019, Qingguang et al., 2016, Perlman et al., 2019, Sabet et al., 2021, Tanaka et al., 2018, Tosun et al., 2017, Zhang et al., 2024). These significant and prevalent weaknesses in the body of evidence also draw questions about the validity of attempts to perform systematic reviews and meta-analyses (Hua et al., 2021, Wu et al., 2022).

While massage is not invasive and has few adverse effects, it is cumulatively moderate to high cost (when professionally administered). As the current evidence base neither demonstrates clear efficacy nor demonstrates long term benefits and there are other treatments with documented efficacy, it is not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Massage; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 48 articles in PubMed, 7 in CINAHL, 22 in Cochrane Library, 18,400 in Google Scholar, and 5 from other sources†. We considered for inclusion 15 from PubMed, 0 from CINAHL, 1 from Cochrane Library, 12 from Google Scholar, and 5 from other sources. Of the 33 articles considered for inclusion, 30 randomized trials and 3 systematic reviews met the inclusion criteria.

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Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

MANIPULATION OR MOBILIZATION FOR KNEE PAIN, KNEE OSTEOARTHROSIS, OR KNEE FRACTURE

Not Recommended

Joint manipulation or joint mobilization are not recommended for treatment of acute knee pain, knee osteoarthrosis, or knee fracture. There are separate indications for manipulation after arthroplasty.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Manipulation or mobilization has been used for the treatment of knee pain, knee osteoarthrosis, or knee fractures (Salamh et al., 2017, Xu et al., 2017, Anwer et al., 2018, Tsokanos et al., 2021, Weleslassie et al., 2021, Li et al., 2022, Runge et al., 2022, Adams et al., 2024, Lin et al., 2025). There are no quality trials of manipulation or mobilization of the knee compared with sham or incorporating a clinical prediction rule that demonstrate efficacy (see separate recommendations for manipulation after arthroplasty). There is one high-quality study of manipulation in hospitalized knee and hip patients that found a lack of efficacy (Licciardone et al., 2004); however, this study did not include treatment to the hip or knee. There are many low-quality and excluded studies with small sample sizes, missing baseline data, missing CONSORT diagrams, failure to report outcomes data by group assignments, and/or appearing to have randomization failures or other potentially fatal flaws (Witwit et al., 2022, Wirries et al., 2020, Tariq et al., 2020, Taj et al., 2023, Salal et al., 2022, Sharma, 2022, Okita et al., 2022, Nigam et al., 2021, Kaya Mutlu et al., 2018, Kaya Mutlu et al., 2018, Mostamand et al., 2023, Mehmood et al., 2021, Mahmooda et al., 2020, Reza et al., 2021, Pozsgai et al., 2022, Pozsgai et al., 2022, Dantas et al., 2025, Abbott JH, 2015, Alkhawajah et al., 2019, Alsiri et al., 2025, Karaborklu Argut et al., 2021, Bhagat et al.,

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2020, Buke et al., 2024, Courtney et al., 2016, Demirci et al., 2017, Gupta et al., 2015, Kiran et al., 2018, Kulkarni et al., 2017, Lalnunpuii et al., 2017, Lin et al., 2025).

One pilot comparative study's data suggested the best results were in the exercise group (Dwyer et al., 2015). Another trial compared exercise, exercise-with boosters, manual therapy plus exercise, manual therapy plus exercise with boosters and found minimal benefits in the highest intensity treatment group (which had significant contact time/attentional biases) with no differences at 1 year (Fitzgerald et al., 2016). Soft tissue mobilization showed equivalency with stretching in a trial among patients with knee OA (Nafees et al., 2023). Another trial suggested strengthening exercises were superior to mobilization in patients with knee OA (Nazir et al., 2024). A trial of exercise, education, manual therapy and taping v. education alone found no minimal benefits of the intensive treatment group (Crossley et al., 2015). One trial reported equivalency between Maitland and Mulligan mobilization (Rao et al., 2018).

A systematic review concluded that while there was low quality evidence of some evidence supporting manual therapy as an adjunct to exercise therapy, there is no evidence of functional benefit from manual therapy (Runge et al., 2022). There was some evidence of effectiveness of mobilization, although the magnitude was modest (Li et al., 2022). There are no systematic reviews on manipulation for knee OA.

Thus, the overall literature base is quite limited and further quality studies are needed, as there are many studies weaknesses, including difficulty in separating out the effect of other interventions included such as exercise.

Manipulation and/or mobilization is not invasive, has low adverse effects, but is moderate to high cost depending on the number of treatments. As there is no quality evidence of durable effects, manipulation or mobilization is not recommended to treat these patients, with the exception of select postoperative patients (see separate recommendation).

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Manipulation, mobilization, manual therapy; osteoarthritis, osteoarthrosis, acute knee pain, knee fractures, knee surgery; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 329 articles in PubMed, 107 in CINAHL, 954 in Cochrane Library, 19,900 in Google Scholar, and 22 from other sources†. We considered for inclusion 16 from PubMed, 0 from CINAHL, 2 from Cochrane Library, 7 from Google Scholar, and 22 from other sources. Of the 47 articles considered for inclusion, 33 randomized trials and 14 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and

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Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

MANIPULATION OR MOBILIZATION FOR POSTOPERATIVE PATIENTS WITH SIGNIFICANTLY REDUCED RANGE OF MOTION

Sometimes Recommended

Manipulation is recommended for select postoperative patients with significantly reduced range of motion.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Patients with significantly reduced postoperative range of motion that is not trending towards recovery of functional range of motion typically after at least 6-8 weeks postarthroplasty may benefit from manipulation. Manipulation under anesthesia is an option. If not performed by the operating surgeon, this needs to be carefully coordinated with that orthopedic surgeon.

Benefits

Improved range of motion and potential for regaining functional recovery.

Harms

Pain, intolerance of the manipulation, increased post-manipulation pain, theoretical dislodging of the prosthesis.

Frequency/Dose/Duration

An initial trial of 1-3 manipulation treatments. If there are significant gains in ROM, yet are insufficient for functional recovery of ROM, then an additional set of manipulation treatments may be reasonable. Added sets of treatments are not indicated when there is either a lack of range of motion gain, or reaching of a plateau in improving ROM.

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Indications for discontinuation

Recovery of sufficient functional ROM, intolerance, reaching a plateau in ROM.

Rationale

Manipulation has been used for the treatment of postoperative patients with reduced range of motion (Pichonnaz et al., 2016, Serino et al., 2017, Lu et al., 2024, Aftab et al., 2025, Sahni et al., 2025). There are no quality trials of manipulation or mobilization compared with either sham or other controls for those patients with insufficient post-arthroplasty range of motion. While there are trials of manipulation, there are no quality trials of mobilization to assess its efficacy. Manipulation is not invasive, has generally low adverse effects provided it is performed after bony ingrowth occurs, but is moderately costly depending on the number of treatments. An initial trial of 1-3 treatments may be reasonable for these patients, but should be closely coordinated with the orthopedic surgeon and if there are insufficient results, either more aggressive physical therapy and/or manipulation under anesthesia is generally the next procedure.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Manipulation, mobilization, manual therapy; reduced range of motion, post-operative knee; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 384 articles in PubMed, 180 in CINAHL, 80 in Cochrane Library, 17,500 in Google Scholar, and 4 from other sources†. We considered for inclusion 12 from PubMed, 2 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 5 from other sources. Of the 19 articles considered for inclusion, 13 randomized trials and 6 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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MANIPULATION UNDER ANESTHESIA FOR POSTOPERATIVE PATIENTS WITH SIGNIFICANTLY REDUCED RANGE OF MOTION

Sometimes Recommended

Manipulation under anesthesia is recommended for select postoperative patients with significantly reduced range-of-motion. This may be performed under general or regional anesthesia typically by the operating orthopedist (Panni et al., 2005).

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Patients with significantly reduced range of motion post-arthroplasty who are also past the initial bony ingrowth phase of typically 6-8 weeks, and are also not trending towards achieving a functional recovery. Late manipulation under anesthesia is much less successful, especially 10-12 weeks.

Benefits

Improved range of motion and potential for regaining functional recovery.

Harms

Increased post-manipulation pain, theoretical dislodging of the prosthesis.

Frequency/Dose/Duration

Generally performed only once. May be attempted a second time if there was partial but incomplete gain after the first procedure.

Rationale

Manipulation under anesthesia has been used for the treatment of post-operative patients with reduced range of motion (Gu et al., 2018, Akhtar et al., 2024). There are no quality trials of manipulation under anesthesia compared with either sham or other controls for those patients with insufficient post-arthroplasty range of motion. One trial found no adjunctive benefit of IV steroid plus 14 days of celecoxib (Abdel et al., 2024). A low-quality study with only 10 control patients suggested comparability between MUA and multimodal physical therapy (Rauzi et al., 2022). Systematic reviews conclude there is good nonrandomized evidence of efficacy (Gu et al., 2018, Akhtar et al., 2024). Manipulation under anesthesia is not invasive, has generally low adverse effects provided it is performed after bony ingrowth occurs, but is high cost. Because there are few other options, it is selectively recommended for these patients.

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Manipulation under anesthesia; Range of motion, post-operative knee pain, post-operative period; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 189 articles in PubMed, 14 in CINAHL, 39 in Cochrane Library, 14,500 in Google Scholar, and 4 from other sources†. We considered for inclusion 1 from PubMed, 1 from CINAHL, 1 from Cochrane Library, 0 from Google Scholar, and 1 from other sources. Of the 4 articles considered for inclusion, 1 randomized trial and 3 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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REFLEXOLOGY

Reflexology is a complementary or alternative treatment. It entails the physical act of applying pressure to the feet and hands with specific thumb, finger, and hand techniques without the use of oil or lotion. Reflexology is based on a system of zones and reflex areas that reflect an image of the body on the feet and hands. Work on the feet and hands are thought to effect physical changes to the body.

REFLEXOLOGY FOR KNEE OSTEOARTHROSIS OR KNEE PAIN

Not Recommended

Reflexology is not recommended for the treatment of knee osteoarthrosis or acute, subacute, or chronic knee pain.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

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There are no quality studies of reflexology for knee pain, and the low quality studies have many methodological weaknesses (Abdelaziz, 2019, Baraka, 2022, Kiani Dooghabadi et al., 2020, Yakout et al., 2022). Reflexology also has not been shown to be efficacious for the treatment of chronic LBP in a moderate-quality study (Poole et al., 2007). Other treatments have been shown to be efficacious and as it is cumulatively moderate to high cost, reflexology is not recommended for treatment of patients with knee pain including knee OA.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Reflexology, foot reflexology, hand reflexology, zone therapy; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 200 articles in PubMed, 0 in CINAHL, 21 in Cochrane Library, 16,200 in Google Scholar, and 1 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 3 from Google Scholar, and 1 from other sources. Of the 4 articles considered for inclusion, 4 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ACUPUNCTURE

Acupuncture has been used to treat many musculoskeletal conditions including hip [749] and spine pain and osteoarthrosis, particularly of the knee [750,751], and there is some evidence that patients seek this treatment if they have more severe pain [752]. Multiple techniques have been used, including manual needle stimulation, electrical needle stimulation [753,754,755] (electroacupuncture), superficial dry needling, and deep dry needling [756,757]. Acupuncture administration may involve moxibustion and cupping [758]. Moxibustion is a

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traditional Chinese therapy involving burning of an herb (mugwort) to stimulate blood flow and balance "Qi." Cupping is another ancient Chinese practice involving placement of a cup on the skin with negative pressure induced either through heat or suction with tension placed on the underlying tissue. Besides traditional acupuncture, there are many other types of acupuncture that have arisen, including accessing non-traditional acupuncture points [(759)]. Quality evidence has documented that use of traditional acupuncture locations is not necessary to derive equivalent benefits from treatment of low back pain (see Chronic Pain and Low Back Disorders guidelines) [(760,761,762)].

ACUPUNCTURE FOR KNEE OSTEOARTHROSIS

Sometimes Recommended

Acupuncture is selectively recommended for treatment of chronic osteoarthrosis of the knee as an adjunct to more efficacious treatments.

Strength of evidence Recommended, Evidence (C)
Level of confidence Low

Indications

Moderate to severe chronic osteoarthrosis of the knee. Prior treatments should include NSAIDs, weight loss, and exercise, including a graded walking program and strengthening exercises. May be selectively considered as an adjunct to a conditioning program that has resulted in insufficient clinical response, and generally used for those who are either not candidates for arthroplasty or decline surgery. It is not recommended for treatment of acute and subacute knee pain.

Frequency/Dose/Duration

A limited course of 6 appointments (Haslam, 2001) with clear objective and functional goals to be achieved. Additional appointments should require documented functional benefits, lack of plateau in measures and probability of obtaining further benefits. There is quality evidence suggesting traditional acupuncture needle placement may be unnecessary (Fink et al., 2001) and that superficial needling is as successful as deep needling (Scharf et al., 2006, Takeda et al., 1994). There is evidence suggesting it is not necessary to perform bilateral needling (Tillu et al., 2001), although that result has not been replicated.

Indications for discontinuation

Resolution, intolerance, and noncompliance, including noncompliance with aerobic and strengthening exercises.

Rationale

Acupuncture, acupressure, acupotomy, moxibustion or periosteal dry needling has been used for the treatment of knee pain (Lin et al., 2016, Shim et al., 2016, MacPherson et al., 2017, Chen et al., 2023, Chen et al., 2019, Chen et al., 2024, Zhang et al., 2017, Li et al.,

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2018, Sun et al., 2019, Li et al., 2020, Wang et al., 2020, Lam et al., 2021, Yang et al., 2021, Lin et al., 2020, Jun et al., 2022, Lee et al., 2023, Ma et al., 2023, Mei et al., 2023, Han et al., 2024, Liu et al., 2024, Yuan et al., 2024, Ho et al., 2025, Zheng et al., 2023).

There are many high- and moderate-quality studies that evaluated acupuncture for the treatment of knee osteoarthrosis (Takeda et al., 1994, Witt et al., 2006, Christensen et al., 1992, Petrou et al., 1988, Molsberger et al., 1994, Berman et al., 2004, Berman et al., 1999, Vas et al., 2004, Ammer et al., 1988, Jia et al., 2005, Sangdee et al., 2002, Tukmachi et al., 2004, Kim et al., 2010, Nejrup et al., 2008)(Dunning et al., 2018, Lam et al., 2021, Lee et al., 2022, Tu et al., 2021, Zheng et al., 2023, Kang et al., 2020, Li et al., 2020, Ju et al., 2015, Sun et al., 2025, Eucker et al., 2024, Liu et al., 2022, Ng et al., 2025, Atalay et al., 2021, Guo et al., 2025, Jaberi et al., 2019). There are many low-quality and excluded studies with small sample sizes, missing baseline data, missing CONSORT diagrams, failure to report outcomes data by group assignments, and/or appearing to have randomization failures or other potentially fatal flaws (Akbarnezhad et al., 2019, Cheung et al., 2020, Elbadawy, 2017, Guo et al., 2025, Hinman et al., 2015, Jeong et al., 2025, Jia et al., 2020, Jun et al., 2020, Lele et al., 2019, Lin et al., 2018, Lv et al., 2019, Mezaal et al., 2019, Park et al., 2017, Qi et al., 2016, Shi et al., 2020, Venuti et al., 2023, Wang et al., 2020, Yu et al., 2016, Wei et al., 2024, Woo et al., 2022, Nie et al., 2025). There are also multiple trials which suggest superiority to usual care or no acupuncture (Lansdown et al., 2009, Berman et al., 1999, Ng et al., 2025, Jensen et al., 1999, Liu et al., 2022, Tukmachi et al., 2004, Suarez-Almazor et al., 2010)(Witt et al., 2006, Witt et al., 2005), but these have strong usual-care or wait-list biases and thus are unable to show efficacy.

Sham controlled trials conflict somewhat, with most (Scharf et al., 2006, Tsang et al., 2007, Berman et al., 2004, Takeda et al., 1994, Naslund et al., 2002, Lam et al., 2021) but not all (Jubb et al., 2008, Vas et al., 2004, Li et al., 2018) sham-controlled trials suggesting equivalency to acupuncture. This naturally raises further questions regarding efficacy.

One trial found significant adjunctive effect of dry needling added to exercise plus manual therapy, with benefits that endured to the 3-month follow-up (Dunning et al., 2018), while another trial found dry needling to be ineffective (Mason et al., 2016). Another trial found lack of efficacy of dry needling for treatment of hamstring flexibility (Mason et al., 2016). A trial of acupuncture that included sham and a medication treatment arm found superiority of either acupuncture/sham, while finding equivalency between acupuncture and sham (Scharf et al., 2006). One trial of 4 weeks of acupuncture was not superior to sham in which the needles were not inserted but attention was otherwise the same, either at 4 or 10 weeks (Lam et al., 2021). A trial of electroacupuncture v. manual acupuncture v. sham acupuncture found no differences between electro- and manual-acupuncture but reported superiority to sham; however, sham was the only arm where de qi was not elicited and thus there is a likely attentional bias and a questionable success of sham (Tu et al., 2021). One trial suggested acupuncture is not of additive benefit to exercise (Foster et al., 2007) and another found acupuncture of approximate equivalency to physiotherapy (Williamson et al., 2007).

Trials of auricular acupuncture suggests efficacy in reducing analgesia requirements peri-operative (Usichenko et al., 2007), intra-operative (Usichenko et al., 2006), and post-

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operative (Usichenko et al., 2005). Either verum or sham, self-acupressure was superior to usual care (Li et al., 2018).

Some have concluded that the evidence suggests that there is no effect of acupuncture on pain (Moe et al., 2007). Some trials have combined acupuncture with electrical currents, others have applied electrical currents to acupuncture sites (Sangdee et al., 2002, Jubb et al., 2008, Naslund et al., 2002), and one involved periosteal stimulation (Weiner et al., 2007). There are no quality studies to show clear benefit of electroacupuncture over needling. Studies reporting results after the cessation of acupuncture have nearly all reported benefits lasting beyond the length of the trial (Witt et al., 2006, Suarez-Almazor et al., 2010), although there are no long-term follow-up reports. One trial showed greater effects for those provided a higher number of treatments, but the contact-time bias limits the strength of the conclusion (Lin et al., 2020).

High-quality studies with sizable populations and long follow-up periods are needed for all of these potential indications. Systematic reviews with meta-analyses have concluded that the overall evidence is low, has significant heterogeneity, is potentially biased, but that there is some evidence of efficacy of acupuncture (Chen et al., 2024, Yang et al., 2023, Zhang et al., 2017, Sun et al., 2019, Lin et al., 2016, Liu et al., 2024). While there is evidence of intermediate-term efficacy at 3 months (Chen et al., 2024, Zhang et al., 2017, Lin et al., 2016), by 9 months it is not efficacious (Chen et al., 2024, Lin et al., 2016). Systematic reviews of electroacupuncture also suggest efficacy (Shim et al., 2016, Yuan et al., 2024), with greater efficacy for greater intensity (Yuan et al., 2024).

Yet, there continue to be questions about efficacy of acupuncture (Manheimer et al., 2006, Manheimer et al., 2005), especially with the number of negative sham-controlled trials (see above), as well as with concerns about biases, e.g., attention and expectation bias in these study designs as well as the adequacy of placebo acupuncture treatments (White et al., 2003, Boutron et al., 2003). One trial demonstrated acupuncturist behaviors to set positive expectations had a significant impact on outcomes from acupuncture (Suarez-Almazor et al., 2010).

Acupuncture when performed by experienced professionals is minimally invasive, has minimal adverse effects, and is moderate to high cost cumulatively. Despite significant reservations regarding its true mechanism of action, a limited course of acupuncture may be recommended for select patients for treatment of knee osteoarthrosis (especially for those who are not candidates for arthroplasty) as an adjunct to a conditioning and weight loss program which should remain as the primary focus. Acupuncture is not recommended for those not involved in a conditioning program or who are non-compliant with graded increases in activity levels.

Acupuncture is not recommended for treatment of acute and subacute knee pain as there is no quality evidence for those applications, there are many other treatments with documented efficacy, and cumulatively, it is high cost.

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Acupuncture, acupuncture therapy; Osteoarthritis, osteoarthrosis, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 383 articles in PubMed, 47 in CINAHL, 169 in Cochrane Library, 18,000 in Google Scholar, and 12 from other sources†. We considered for inclusion 28 from PubMed, 2 from CINAHL, 5 from Cochrane Library, 16 from Google Scholar, and 12 from other sources. Of the 63 articles considered for inclusion, 33 randomized trials and 30 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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LOW-LEVEL LASER THERAPY

Low-level laser treatment (LLLT) usually involves laser energy that does not induce significant heating. Low-level laser exposures are theorized to induce photoactivation of the oxidative chain [763,764,765]. LLLT is low risk and without significant reported side effects [766].

LOW-LEVEL LASER THERAPY FOR KNEE OSTEOARTHROSIS OR KNEE PAIN

Not Recommended

The use of low-level laser therapy is not recommended for treatment of osteoarthrosis and acute, subacute, or chronic knee pain.

Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

Laser therapy has been used for the treatment of knee pain (Huang et al., 2015, Rayegani et al., 2017, Vassão et al., 2021, Malik et al., 2023, Fan et al., 2024, Khalilizad et al., 2024,

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Oliveira et al., 2024). Most sizable, sham-controlled trials of low-level laser (or high-level laser) are negative (Rogvi-Hansen et al., 1991, Yurtkuran et al., 2007, Ekici, 2023, Bulow et al., 1994, Shen et al., 2009)(Rogvi-Hansen et al., 1991, Yurtkuran et al., 2007), although a few trials suggested potential efficacy (Dos Santos Maciel et al., 2025, Robbins et al., 2022, Gur et al., 2003). There are many low-quality and excluded studies with weaknesses that include small sample size, lack of description of baseline data, differences in baseline data suggesting randomization failure and/or lack of CONSORT diagrams (Pasin et al., 2025, Ahmad et al., 2022, Alfredo et al., 2012, Alfredo et al., 2018, Alghadir et al., 2014, Astri et al., 2023, Chia et al., 2025, Elboim-Gabyzon et al., 2023, Fakhari et al., 2021, Fukuda et al., 2011, Gomes Gobbi et al., 2019, Stausholm et al., 2022, Kheshie et al., 2014, Ip et al., 2015, Koutensael, 2017, Liao et al., 2020, Melo et al., 2024, Pinto et al., 2022, Rayegani et al., 2012, Ezzati et al., 2024, Vassão et al., 2020, Vassão et al., 2021).

A systematic review with meta-analysis of randomized "placebo-controlled" trials consisted mostly of the very small studies (<20/group) and found evidence of efficacy of up to 12 weeks after LLLT (Stausholm MB, 2019). Because the underlying studies are low quality and have problems such as baseline differences between groups, the reliability of the meta-analysis appears limited.

LLLT is not invasive, has low adverse effects, is moderately to highly costly based on the number of treatments required, has mostly negative results in quality, sham-controlled trials for the treatment of the knee, and other effective treatment options exist. Thus, LLLT is not recommended for treatment of knee pain or osteoarthrosis.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: low-level laser therapy, laser therapy, osteoarthritis, knee osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 121 articles in PubMed, 0 in CINAHL, 29 in Cochrane Library, 16200 in Google Scholar, and 0 from other sources†. We considered for inclusion 23 from PubMed, 0 from CINAHL, 1 from Cochrane Library, 11 from Google Scholar, and 0 from other sources. Of the 35 articles considered for inclusion, 28 randomized trials and 7 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

SHOCKWAVE THERAPY

SHOCKWAVE THERAPY FOR KNEE OSTEOARTHROSIS

No Recommendation

There is no recommendation for or against shockwave therapy for knee osteoarthritis.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Shockwave therapy has been used for the treatment of knee osteoarthrosis (Liao et al., 2019, Liao et al., 2024, Li et al., 2019, Avendaño-Coy et al., 2020, Chen et al., 2020, Hsieh et al., 2020, Ma et al., 2020, Wang et al., 2020, Silva et al., 2023, Chen et al., 2024, Mingwang et al., 2024). A sham-controlled trial found lack of efficacy at 2,000 impulses/session, 0.10-0.16 mJ/mm2 positive energy flux density (Imamura et al., 2017). A second sham-controlled trial found evidence of efficacy at 4,000 impulses, 0.25mJ/mm2 and at 6Hz that persisted to 12 weeks (Zhao et al., 2013), and a third sham-controlled trial also reported efficacy (2000 pulses at 8Hz and 2.5 bars of pneumatic pressure) for pain and function but reported adverse effects on the cartilage (Zhong et al., 2019). A trial of varying ESWT intensities reported minimally better efficacy with the higher dose (Kim et al., 2015). One trial found focused ESWT superior to radial ESWT (Ko et al., 2022). A trial found ESWT superior to kinesiotherapy (Lizis et al., 2017). A trial reported comparable (in)efficacy with 3 treatments each of ESWT v. intraarticular hyaluronic acid injection (Lee et al., 2017).

There are many low-quality studies and excluded studies due to problems including small sample size, no baseline demographic data, sparse data, and no CONSORT diagram (Uysal et al., 2020, Zhang et al., 2021, Mostafa et al., 2022, Lizis et al., 2017, Wang et al., 2020, Jhan et al., 2022, Hammam et al., 2020, Ho et al., 2022, Günaydin Ö et al., 2022, Elerian et al., 2016, Eftekharsadat et al., 2020, Ediz et al., 2018, Cho et al., 2016, Choi et al., 2023, Chen et al., 2014, Arshed, 2024, Pasin et al., 2025, Al-Abbad et al., 2024). An AAOS guideline opined the evidence was limited (American Academy of Orthopaedic Surgeons, 2021).

ESWT is not invasive, has low adverse effects and is high cost. As the existing sham-controlled trials significantly conflict, there is no recommendation.

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: extracorporeal shockwave therapy, shockwave therapy, osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 53 articles in PubMed, 2 in CINAHL, 17 in Cochrane Library, 8,840 in Google Scholar, and 5 from other sources†. We considered for inclusion 19 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 12 from Google Scholar, and 5 from other sources. Of the 36 articles considered for inclusion, 24 randomized trials and 12 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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RADIOFREQUENCY ABLATION

RADIOFREQUENCY ABLATION FOR KNEE OSTEOARTHROSIS

No Recommendation

There is no recommendation for or against radiofrequency ablation for knee OA.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

One sham-controlled trial suggested lack of efficacy of RF ablation of the genicular nerves for treatment of knee OA (Malaithong et al., 2023). A comparative trial found RF ablation plus intraarticular chitosan superior to an anesthetic block injection plus chitosan, with graphic data also suggesting waning efficacy at 6 months (Ma et al., 2024). Some trials assessed RF techniques (Elemam et al., 2022, Mohamed et al., 2021). Another comparative trial appears to show relatively modest superiority of RF to PRP injections, although the tabular data specify the comparisons are with each group's baseline and not between-

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groups (Elawamy et al., 2021). Another trial suggested modest superiority of PRP to RF (Anwar et al., 2025). One trial suggested additive benefit of RF to passive stretching (Han et al., 2021). Another trial suggested superiority of RF ablation to one hyaluronic acid injection (Chen et al., 2020). There are many low-quality and excluded studies mostly due to small sample sizes (Adosary et al., 2025, Chen et al., 2020, Choi et al., 2011, Kwon et al., 2024, Lyman et al., 2022, McCormick et al., 2018, Mishra et al., 2021, Ray et al., 2018, Sari, 2016, Vallejo, 2023, Xiao et al., 2018, Davis et al., 2019).

Radiofrequency ablation is minimally invasive, has adverse effects, is high cost and has no evidence of durable efficacy. Nerve ablation could potentially be contraindicated for those undergoing arthroplasty due to denervation of the joint that is needed for rehabilitation, thus long-term safety is unclear. If radiofrequency ablation has a future role in knee OA management, it appears potentially to be for those who are ineligible for arthroplasty. Meanwhile, more sham-controlled trials with sufficient sample sizes and duration of follow-up are needed.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: radiofrequency ablation; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 119 articles in PubMed, 94 in CINAHL, 22 in Cochrane Library, 18,900 in Google Scholar, and 0 from other sources†. We considered for inclusion 30 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 13 from Google Scholar, and 0 from other sources. Of the 31 articles considered for inclusion, 17 randomized trials and 14 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ELECTRICAL THERAPIES

OVERVIEW

There are multiple forms of electrical therapies used to treat musculoskeletal pain. These include electrical stimulation therapies, iontophoresis, interferential therapy (IFT or IT), microcurrent therapy, percutaneous electrical nerve stimulation (PENS), and transcutaneous electrical stimulation (TENS) [767,768,769,770,771,772,773,774]. The mechanism(s) of action, if any, are unclear.

ELECTRICAL STIMULATION THERAPIES

Neuromuscular electrical stimulation has been used particularly to strengthen the quadriceps femoris [775-778]. Many studies using electrical stimulation have been reported both for treating patients with osteoarthrosis [779], patellofemoral pain [780], post-surgical knee patients [781-785], as well as in healthy athletes to attempt to improve performance [786-795].

ELECTRICAL STIMULATION THERAPIES FOR KNEE OSTEOARTHROSIS OR KNEE PAIN

No Recommendation

There is no recommendation for or against the use of electrical stimulation therapies for the treatment of knee osteoarthrosis or acute, subacute, or chronic knee pain.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Neuromuscular electrical stimulation therapy has been used for the treatment of knee osteoarthrosis and knee pain (Novak et al., 2020, Bispo et al., 2021). One sham-controlled trial of a home device reported efficacy of NMES for most measures (Sax et al., 2022). A trial of NMES vs. exercise vs. NMES plus exercise found all three arms improved, with most data suggesting the arms with NMES outperformed exercise alone (Moezy et al., 2024). A four-arm trial with TENS, interferential therapy, Aussie current, and placebo found minimal differences at 4 weeks (De Almeida et al., 2025). One moderate-quality trial found NMES to be superior to ultrasound (Devrimsel et al., 2019). One trial of whole body electromyostimulation vs. usual care reported efficacy, but was subject to strong usual care, contact time, and attention biases (Kast et al., 2024). There are multiple low-quality trials, mostly with small sample sizes (Oldham JA, 1995, Elsehrawy et al., 2025, Melo et al., 2024, da Graca-Tarragó et al., 2019).

Neuromuscular stimulation is noninvasive, has low adverse effects, but is moderate to high cost with either prolonged treatment or use of some devices. Other treatments shown to be effective are available. There is no recommendation for or against the use of NMES. It may be a reasonable consideration for patients who are not candidates for arthroplasty.

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Electric Stimulation Therapy; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 133 articles in PubMed, 4 in CINAHL, 27 in Cochrane Library, 17,700 in Google Scholar, and 0 from other sources†. We considered for inclusion 11 from PubMed, 1 from CINAHL, 1 from Cochrane Library, 15 from Google Scholar, and 0 from other sources. Of the 28 articles considered for inclusion, 22 randomized trials and 8 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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TRANSCRANIAL DIRECT CURRENT STIMULATION (TDCS) FOR KNEE OSTEOARTHROSIS

Sometimes Recommended

Transcranial direct current stimulation is selectively recommended for patients with knee OA, primarily for those who are not candidates for arthroplasty.

Strength of evidence Recommended, Evidence (C)
Level of confidence Low

Indications

Patients with moderate to severe knee OA who have insufficient results from an aerobic and strengthening exercise program plus medications (typically topical or oral NSAIDs). Generally, patients who are not eligible for arthroplasty.

Benefits

Improved pain and function.

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Harms

Negligible.

Frequency/Dose/Duration

15-daily sessions of 20min duration was used in one trial (Martorella et al., 2022).

Indications for discontinuation

Non-compliance, sufficient recovery, intolerance

Rationale

A moderate quality sham-controlled trial reported significant differences, although the benefits of TDCS were reduced by 3-months (Martorella et al., 2022). Another RCT found reported modest benefits of TDCS when added to TENS compared with sham TDSC+TENS (Xia et al., 2025).

TDCS is not invasive, has low adverse effects, is moderate to high cost cumulatively and depending on the device used. However, the durability of results is somewhat unclear, and the quality study data suggests the benefits are not be particularly durable. Patients should have moderate to severe knee OA who have insufficient results from an aerobic and strengthening exercise program plus medications (typically topical or oral NSAIDs). Generally, patients who are not eligible for arthroplasty may be reasonable candidates to attempt TDCS.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Electromagnetic Fields; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 45 articles in PubMed, 20 in CINAHL, 25 in Cochrane Library, 17,800 in Google Scholar, and 2 from other sources†. We considered for inclusion 3 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 4 from Google Scholar, and 0 from other sources. Of the 7 articles considered for inclusion, 7 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior

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guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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IONTOPHORESIS

IONTOPHORESIS FOR KNEE OSTEOARTHROSIS OR KNEE PAIN

Not Recommended

Iontophoresis is not recommended for the treatment of knee osteoarthrosis or acute, subacute or chronic knee pain.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

There are no quality studies for any of iontophoresis for treatment of knee osteoarthrosis. Multiple low-quality and excluded studies have used a wide range of agents, all with small sample sizes (Lasisi et al., 2024, Onigbinde et al., 2023, Dakowicz et al., 2022, El Kasem et al., 2024, Ashburn et al., 1992, Li et al., 1995).

Iontophoresis therapy is noninvasive with low adverse effects, but it is moderate to high cost depending on the number of treatments. With an absence of quality evidence of efficacy, it is not recommended for treatment of osteoarthrosis or other causes of knee pain.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Iontophoresis; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 0 in CINAHL, 0 in Cochrane Library, 4,140 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 5 from Google Scholar, and 0 from other sources. Of the 5 articles considered for inclusion, 5 randomized trials and 0 systematic reviews met the inclusion criteria.

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Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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PHONOPHORESIS

PHONOPHORESIS FOR KNEE OSTEOARTHROSIS

Not Recommended

Phonophoresis is not recommended for knee osteoarthrosis.

Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

Phonophoresis has been used for the treatment of knee pain (Wobma, 2020, Martin-Vega et al., 2022, Yang et al., 2022, Yang et al., 2021). There is one moderate-quality study evaluating phonophoresis with ibuprofen compared to ultrasound and found no difference between the two therapies. The authors reported that both groups were improved over the 2 weeks of therapy (Kozanoglu et al., 2003). There are many low quality studies. Thus, as there is not evidence of efficacy, phonophoresis is not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Phonophoresis; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 11 articles in PubMed, 7 in CINAHL, 7 in Cochrane Library, 1,300 in Google Scholar, and 4 from other sources†. We considered for inclusion 7 from PubMed, 1 from CINAHL, 0 from Cochrane Library, 4 from Google Scholar, and 4 from other sources. Of the 16 articles

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considered for inclusion, 12 randomized trials and 4 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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THERAPEUTIC ULTRASOUND

ULTRASOUND FOR TREATMENT OF KNEE OSTEOARTHROSIS

Not Recommended

Ultrasound therapy is not recommended for treatment of knee osteoarthrosis.

Strength of evidence Moderately Not Recommended, Evidence (B)
Level of confidence Low

Rationale

Therapeutic ultrasound has been used for the treatment of knee pain (Zhang et al., 2016, Wu et al., 2019, Aiyer et al., 2020, Dantas et al., 2021, Liu et al., 2022, Luo et al., 2024). Multiple sham-controlled trials of ultrasound treatment for knee OA found a lack of benefit from ultrasound (US) (Sawitzke et al., 2022, Karakaş et al., 2020, Falconer et al., 1992, Reed et al., 2000), which also included a 6-week trial of a self-applied US device at home (Draper et al., 2018). One sham-controlled trial reported inexplicably large magnitudes of changes in pain and WOMAC in both US and sham groups not found in other studies and that are also inconsistent with body of evidence; the reported differences between the two groups is minor and of questionable clinically meaningful differences.

Amongst other trials, one suggested a combination of aerobic exercise plus low-intensity pulsed ultrasound (LIPUS) to be superior to either treatment alone (Yang et al., 2025), although the magnitudes of differences are of questionable clinical significance. Another trial found pulsed US plus strengthening exercises better than exercises alone (Huang et al., 2005). One trial found US superior to diathermy (Jia et al., 2022), another found inferiority

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to diathermy (Cetin et al., 2008), another found inferiority to pulsed electromagnetic frequency (Fayez et al., 2022), while another trial comparing US with neuromuscular electrical stimulation found comparable (in)efficacy (Devrimsel et al., 2019), and another reported US of additive benefit to extracorporeal shockwave therapy (Khadour et al., 2025). One trial found LIPUS plus aerobic exercise combination treatments to be better than either aerobic exercise or LIPUS alone (Yang et al., 2025). One small trial of exercises for all and randomized to high-intensity laser therapy vs. US vs. exercise alone found the best results with the high-intensity laser (Samaan et al., 2022). A trial of varying US intensities but no control group reported no superiority of any intensity (BÜYÜKkÖMÜRcÜ et al., 2025). TENS was of no additive benefit to ultrasound in one trial (Sangtong et al., 2019). There are many low quality and/or excluded trials that have weaknesses commonly including sparse methodological data, small sample sizes, and lack of baseline comparability suggesting randomization failure (Ozgonenel et al., 2009, Abdalbary, 2016, Alfredo et al., 2020, Jo et al., 2022, Kuriakose et al., 2022, Kim et al., 2019, Kitano et al., 2023, Loyola-Sánchez et al., 2012, TERZİ et al., 2017).

Because most sham-controlled trials are negative (including the highest quality trials), there is largely consistent, quality evidence that US is ineffective for treatment of knee OA in comparison with sham US; thus, it is not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Ultrasonic therapy, ultrasound therapy; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 117 articles in PubMed, 54 in CINAHL, 37 in Cochrane Library, 17,200 in Google Scholar, and 6 from other sources†. We considered for inclusion 2 from PubMed, 3 from CINAHL, 4 from Cochrane Library, 17 from Google Scholar, and 10 from other sources. Of the 36 articles considered for inclusion, 30 randomized trials and 6 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

INTERFERENTIAL THERAPY

INTERFERENTIAL THERAPY FOR POSTOPERATIVE KNEE PATIENTS

No Recommendation

There is no recommendation for or against interferential therapy for osteoarthrosis, post-operative ACL reconstruction, meniscectomy, and knee chondroplasty.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Frequency/Dose/Duration

At home, 3 times a day for up to 9 weeks (Jarit et al., 2003).

Indications for discontinuation

Unable to participate in active rehabilitation program; no response after 1 to 3 treatments.

Rationale

Interferential therapy has been used for the treatment of postoperative knees (Almeida et al., 2018, Chen et al., 2022, French et al., 2024). A sizable, moderate-quality sham-controlled trial of interferential therapy found lack of efficacy (Varapirom et al., 2024). Another sham-controlled trial has some baseline differences making interpretation challenging, but appears to have better results in the combination interferential plus photobiomodulation group (Alqualo-Costa et al., 2021). One moderate-quality placebo-controlled trial among elderly residence home patients reported improved pain, range of motion, and post-operative edema up to 9 weeks compared to placebo therapy (Jarit et al., 2003). There are multiple low-quality trials that mostly have small sample sizes (Ahmed et al., 2025, Eftekharsadat et al., 2015, Gomes Gobbi et al., 2019, Artuç et al., 2023), two of which suggest lack of efficacy in comparison with a sham (Artuç et al., 2023) and lack of significant additive value to exercise (Gomes Gobbi et al., 2019).

Interferential therapy is not invasive, has few adverse effects, but is moderately costly. With conflicting evidence of efficacy, there is no recommendation.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: interferential therapy; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly;

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systematic, systematic review, retrospective, and prospective studies. We found and reviewed 15 articles in PubMed, 1 in CINAHL, 26 in Cochrane Library, 3,630 in Google Scholar, and 1 from other sources†. We considered for inclusion 2 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 6 from Google Scholar, and 1 from other sources. Of the 9 articles considered for inclusion, 6 randomized trials and 3 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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MICROCURRENT THERAPY

MICROCURRENT THERAPY FOR POSTOPERATIVE TOTAL KNEE ARTHROPLASTY

No Recommendation

There is no recommendation for or against the use of microcurrent therapy for total knee arthroplasty post-operative pain control.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Microcurrent therapy has been used after knee arthroplasty (Iijima et al., 2021). A moderate-quality, sham-controlled trial of microcurrent therapy for acute knee pain showed minimal differences compared with sham treatment (Lawson et al., 2021). There are low-quality trials with small sample sizes (El-Husseini et al., 2007, Ranker et al., 2020). Because data are sparse and unconvincing regarding efficacy, there is no recommendation for or against microcurrent therapy.

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Microcurrent Therapy; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 2 in CINAHL, 1 in Cochrane Library, 1,150in Google Scholar, and 0 from other sources†. We considered for inclusion 2 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 3 articles considered for inclusion, 2 randomized trials and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION (TENS)

TENS is a modality to control pain through electrical stimulation delivered by pads placed on the surface of the skin. TENS is used for the treatment of many painful conditions, including both noninflammatory and inflammatory disorders; although it has more typically been used for spine disorders [796-802] (see Chronic Pain and Low Back Disorders guidelines).

TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION (TENS) FOR KNEE OSTEOARTHROSIS OR KNEE PAIN

Not Recommended

Transcutaneous electrical nerve stimulation (TENS) is not recommended for the treatment of knee osteoarthrosis or acute, subacute, or chronic knee pain.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

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TENS has been used for the treatment of knee osteoarthrosis or knee pain (Shi et al., 2021, Wu et al., 2022). The highest quality sham-controlled trials are negative (Reichenbach et al., 2022), and no additive benefit has been reported for TENS (Sangtong et al., 2019). Interferential therapy was also suggested to be superior to TENS (Burch et al., 2008). A moderate-quality sham-controlled trial found TENS to be effective (Katagiri et al., 2025).

There are many other moderate-quality trials. Some low-quality trials have suggested modest benefits from TENS (Fargas-Babjak et al., 1989, Smith et al., 1983, Cheing et al., 2002, Cheing et al., 2003)(Sajadi et al., 2020, Iijima et al., 2020), while others have suggested no benefits (Jensen et al., 1991, Anderson et al., 1989, Walker et al., 1991, Alcidi et al., 2007)(Mahmood et al., 2018). Seven of the moderate-quality studies did not find any significant improvement with the use of TENS (Cetin et al., 2008, Cheing et al., 2004, Adedoyin et al., 2005, Breit et al., 2004, Grimmer, 1992, Paternostro-Sluga et al., 1999, Lewis et al., 1994), while nine reported some benefit compared to control (Yurtkuran et al., 1999, Ng et al., 2003, Lewis et al., 1984, Law et al., 2004, Law et al., 2004, Itoh et al., 2008, Taylor et al., 1981, Lone et al., 2003, Parker, 2006).

TENS is not invasive, has few adverse effects, and is moderately costly. However, as the highest quality sham-controlled trials show no efficacy, TENS is not recommended to treat knee OA or pain.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: transcutaneous electric nerve stimulation; osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 5 articles in PubMed, 7 in CINAHL, 12 in Cochrane Library, 18,400 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 4 from Google Scholar, and 0 from other sources. Of the 4 articles considered for inclusion, 4 randomized trials and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are

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reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

PERCUTANEOUS ELECTRICAL NERVE STIMULATION (PENS)

PERCUTANEOUS ELECTRICAL NERVE STIMULATION (PENS) FOR KNEE OSTEOARTHROSIS OR OTHER KNEE PAIN

Recommended

Percutaneous electrical nerve stimulation (PENS) is recommended for knee osteoarthrosis or other knee pain.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Patients with moderate to severe knee OA or other chronic knee pain who obtain inadequate control of symptoms with a quality exercise program (aerobic and strengthening) plus medications. Typically, a use would be in those who are not eligible for arthroplasty.

Benefits

Reduced pain and improved function.

Frequency/Dose/Duration

Up to 3 times a week as part of a rehabilitation program (Cetin et al., 2008, Cheing et al., 2004, Adedoyin et al., 2005).

Indications for discontinuation

Patient unable to participate in active rehabilitation program. No response after first treatment (Kang et al., 2007).

Rationale

Percutaneous electrical nerve stimulation (PENS) has been used for the treatment of knee osteoarthrosis or knee pain (Beltran-Alacreu et al., 2022, Heredia Ciuró et al., 2025). One sham-controlled trial reported some evidence of efficacy (Garland et al., 2007). Two other quality sham-controlled trials evaluated patients with knee osteoarthrosis reporting greater pain control compared to placebo (Kang et al., 2007, Garland et al., 2007). A low-quality study evaluated PENS in post-operative patients and reported less muscle atrophy in the PENS group (Eriksson et al., 1979). Another trial reported improved patient and physician

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rated outcomes in the active treatment group after 4 weeks of daily treatment (Zizic et al., 1995). PENS is not invasive, has few adverse effects, is moderately to highly costly, depending on duration of use, and has some evidence of efficacy. Thus, it is selectively recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: percutaneous electric therapy; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 55 articles in PubMed, 12 in CINAHL, 1 in Cochrane Library, 14,000 in Google Scholar, and 0 from other sources†. We considered for inclusion 1 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 0 from other sources. Of the 3 articles considered for inclusion, 1 randomized trial and 2 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

INJECTION THERAPIES

OVERVIEW

There are several types of injections that have been used for patients with knee pain using different approaches. These include intra-articular glucocorticosteroid injections [803-809], viscosupplementation [583], arthroscopic and non-arthroscopic joint lavage, and prolotherapy injections [803]. Percutaneous needle tenotomy has been attempted for chronic tendinoses [810-813]. Tidal volume irrigation of the knee has been utilized for treatment of both inflammatory arthritides as well as osteoarthroses [733,814-817]. Additionally, radiation synovectomy has been utilized for treatment of patients with undifferentiated arthritis and rheumatoid arthritis [818,819].

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Glucocorticosteroid injections, which have been used for the treatment of rheumatoid arthritis and juvenile idiopathic arthritis, are beyond the scope of this guideline [820]. Intra-articular methotrexate and orgotein, which have been used for treatment of rheumatoid arthritis, psoriatic arthritis, and other arthritides [821-824] and oral methotrexate and leflunomide, which have been used for treatment of rheumatoid arthritis, are also beyond the scope of this guideline [825].

Transcranial magnetic stimulation has been used to attempt to make rehabilitation more effective. One small crossover trial with 1 hour follow-up suggested it may make rehabilitation more effective [826].

PLATELET-RICH PLASMA

Autologous blood injections have been used to treat osteoarthritis [827-832]. Autologous growth factors can be injected with autologous whole blood or platelet-rich plasma (PRP) [833]. These injections have been evaluated in studies of plantar foot pain, lateral epicondylalgia, and several other disorders [833,834].

INTRAARTICULAR PLATELET-RICH PLASMA INJECTIONS FOR KNEE OSTEOARTHROSIS

No Recommendation

There is no recommendation for or against intra-articular platelet-rich plasma (including plasma rich in growth factor) for treatment of moderate to severe knee osteoarthrosis (57% of the panel agreed with No Recommendation, whereas 43% agreed with Recommended).

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Indications

Moderate to severe knee osteoarthrosis with insufficient responses to NSAID/acetaminophen, strengthening and aerobic exercise (Argut, 2024). Generally, should also have attempted weight loss and may have trial of knee sleeve/support. Although there is no clear increased risk of infected prosthesis after PRP injection, it is not recommended to inject a knee within 3 months of arthroplasty as an infection may be catastrophic.

Benefits

Improved pain and function, with somewhat conflicting evidence on duration of a modest benefit being 6- vs. 12+ months (Patel et al., 2013, Smith, 2016).

Harms

Hypertension, proteinuria, diarrhea, constipation, rare infections (Yu et al., 2018)

Frequency/Dose/Duration

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One injection should be evaluated to ascertain whether it is effective. Although a series of injections has been trialed, there is uncertainty of that approach as it is prone towards contact-time/interventional biases (Patel et al., 2013, Smith, 2016, Gobbi et al., 2015) (Subramanyam et al., 2021, Tavassoli et al., 2019, Yurtbay et al., 2021, Zhuang, 2024).

Rationale

Intraarticular platelet-rich plasma and plasma rich in growth factor injections have been used for the treatment of knee osteoarthrosis (Lai et al., 2015, Zhang et al., 2018, Chen et al., 2020, Phillips et al., 2020, Ren et al., 2020, Wu et al., 2020, Zhao et al., 2020, Anil et al., 2021, Filardo et al., 2021, Hong et al., 2021, McLarnon et al., 2021, Migliorini et al., 2021, Singh et al., 2022, Zhao et al., 2021, Abbas et al., 2022, Belk et al., 2023, Costa et al., 2023, Simental-Mendía et al., 2019, Qiao et al., 2023, Tao et al., 2023, Xue et al., 2022, Gao et al., 2024, Jawanda et al., 2024, Oeding et al., 2024, Bensa et al., 2025, Berrigan et al., 2025, Du et al., 2025, Khalilizad et al., 2025, Goh et al., 2025, Lameire et al., 2025, Nakagawa et al., 2025, Xu et al., 2025).

There are multiple placebo-controlled trials with many of the trials suggesting modest benefits of PRP compared with placebo (Patel et al., 2013, Smith, 2016, Buendía-López et al., 2018, Baltzer et al., 2009, Lin et al., 2019, Wang et al., 2018, Görmeli et al., 2017) (Barman, 2023, Bennell et al., 2021, Chu et al., 2022, Dório et al., 2021, Elik et al., 2020, Lewis et al., 2022, Nunes-Tamashiro et al., 2022, Raeissadat et al., 2021, Yurtbay et al., 2021); e.g., one trial suggested comparable benefits with either one or two injections at 6 months but superiority compared with placebo yet benefits waned after that point for either 1- or 2-injections (Patel et al., 2013); another trial suggested durable benefits at 12 months of a series of three (3) PRP injections compared to placebo (Smith, 2016); and one trial suggested PRP improved pain and disability (Wu et al., 2018). One placebo-controlled trial with MRI-measured medial tibial cartilage volume found no differences in cartilage volume at 12 months (Bennell et al., 2021). Two moderate-quality trials suggested comparable efficacy to glucocorticoid injection (Joshi Jubert et al., 2017, Güvendi et al., 2018), with one of those trials suggesting longer duration of the PRP (Güvendi et al., 2018). AAOS has also concluded the evidence is weak and they did not support a favorable recommendation (AAOS, 2021). There are many low-quality trials, typically with small sample sizes or sparse methods (Fossati et al., 2024, Gaballa, 2019, Ghai et al., 2019, Huang, 2018, Zhang, 2020, Yoshioka et al., 2024, Tucker, 2021, Smith, 2016, Simental-Mendía et al., 2019, Saraf et al., 2022, Qiao et al., 2024, Mittal et al., 2025, Louis et al., 2021, Kaszyński et al., 2022, Jacob et al., 2017). Other systematic reviews and meta-analyses have conflicted on whether the literature base is sufficient to support a favorable recommendation (Costa et al., 2023, Baria et al., 2022, Singh et al., 2022).

There are many quality comparative trials (Sanchez et al., 2012, Filardo et al., 2012, Cerza et al., 2012, Vaquerizo et al., 2013, Louis et al., 2018) (Bains et al., 2025, Bansal et al., 2021, Fossati et al., 2024, Ghorbani et al., 2024, Zhao et al., 2020, Baria et al., 2022, Huang et al., 2022, Kavadar et al., 2015, Nabi, 2018, Park et al., 2021, Raeissadat et al., 2021, Subramanyam et al., 2021, Szwedowski et al., 2022, Tavassoli et al., 2019, Akan, 2018, Zhuang, 2024, Wang et al., 2022, Wu et al., 2022, Yaradilmis et al., 2020, Tang et al., 2020), mostly showing PRP superiority against viscosupplementation. There is one quality trial of

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injections of PRP vs. Hyaluronic acid vs. NSAID and used MRI imaging, and while the symptoms reportedly improved, there was not evidence of efficacy based on MRI results at one year (Buendía-López et al., 2018). One trial without placebo-control suggested MRI improvements in the PRP group compared with the HA group, with 48% vs. 8% improving at least one OA grade over 12 months (Durmus et al., 2012). Thus, the body of evidence tends to suggest PRP injections tend to be superior to viscosupplementation injections, which appear superior to glucocorticosteroids (see below).

Other comparative trials include bone marrow aspirates (Anz et al., 2022), comparability with microfragmented adipose tissue at up to 12 months (Baria et al., 2022, Baria et al., 2024, Zaffagnini et al., 2022) although another trial found lack of superiority to PRP (Gobbi, 2023), plasma rich in growth factor (Raeissadat et al., 2021), and ozone (Raeissadat et al., 2021). A small trial reported no differences between PRP and PRP combined with intraosseous PRP (Barman et al., 2022, Barman, 2023). There was no benefit of PRP over supervised exercise (Argut, 2024). One trial suggested a dose of at least 10B platelets is important (Bansal et al., 2021), however, there were no dose-ranging arms in the comparison with hyaluronic acid.

There have been attempts to discern whether leukocyte-poor PRP injections may be more effective. However, this line of research appears to have mostly negative findings regarding superiority in the higher quality studies (Abbas et al., 2022, Di Martino et al., 2022, Romandini et al., 2024), and another line of research is regarding whether greater platelet dose leads to superior outcomes (Berrigan et al., 2025). One systematic review with meta-analysis concluded combined PRP and HA was not superior to PRP alone (Baria et al., 2022, Fossati et al., 2024), although others concluded there was adjunctive benefit (Zhao et al., 2020). Superiority to steroids has been found in meta-analyses (McLarnon et al., 2021, Nunes-Tamashiro et al., 2022), although one trial suggested comparable results at 6 months (Pretorius et al., 2022).

PRP injections have also been trialed for preventing post-operative blood loss and have been suggested to improve function in knee arthroplasty patients (Aggarwal et al., 2014, Duif et al., 2015). The duration of the benefit was gone at 6 months in one trial (Aggarwal et al., 2014), but lasted 12 months in the other trial (Duif et al., 2015). PRP has also been trialed with stem cells in a small-sized RCT (Bastos et al., 2018). Concerns about statistical fragility of the continuous outcomes measures for PRP trials have been noted (Lameire et al., 2025) and others have noted lack of key data in reported trials (Nakagawa et al., 2025).

PRP injections are invasive and have a low risk of adverse effects, but they are high cost. Evidence suggests some efficacy for knee OA and superiority to viscosupplementation. However, with preparation heterogeneity, there is no recommendation for or against intra-articular platelet-rich plasma (including plasma rich in growth factor) for treatment of moderate to severe knee osteoarthrosis (57% of the panel agreed with No Recommendation, whereas 43% agreed with Recommended).

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: intraarticular platelet-rich plasma, plasma rich growth factor; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 441 articles in PubMed, 308 in CINAHL, 505 in Cochrane Library, 17500 in Google Scholar, and 30 from other sources†. We considered for inclusion 40 from PubMed, 11 from CINAHL, 4 from Cochrane Library, 0 from Google Scholar, and 16 from other sources. Of the 71 articles considered for inclusion, 37 randomized trials and 31 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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STEM CELL THERAPY

Stem cell therapy has been used for treatment of knee osteoarthrosis [835,836,837,838].

STEM CELL THERAPY FOR KNEE OSTEOARTHROSIS

Not Recommended

Stem cell therapy (including mesenchymal, adipose, placental, umbilical, marrow) is not recommended for the treatment of knee osteoarthrosis (57% of the panel agreed with Not Recommended, whereas 29% agreed with No Recommendation and 14% agreed with Recommended).

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Stem cell therapy has been used for the treatment of knee osteoarthrosis (Cui et al., 2016, Di Matteo et al., 2019, Kim et al., 2019, Huang et al., 2020, Jeyaraman et al., 2021, Ma et al.,

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2020, Song et al., 2020, Wiggers et al., 2021, Gadelkarim et al., 2022, Issa et al., 2022, Shoukrie et al., 2022, Zhao et al., 2022, Zheng et al., 2022, Huang et al., 2023, Kyriakidis et al., 2023, Lee et al., 2024, Kim YM, 2023, Tang et al., 2024, Xiao et al., 2024, Cao et al., 2025, Sadeghirad et al., 2024, Deng et al., 2025, Kasagga et al., 2025, Nguyen et al., 2025, Whittle et al., 2025, Yang et al., 2025, Yin et al., 2025). There are many different sources and methods used in trials (e.g., including mesenchymal stem cells, autologous stem cells, allogeneic stem cells, adipose-derived stem cells, stromal vascular fractions), resulting in an unusually large degree of heterogeneity in the literature. There are a few moderate-sized trials that have been reported (Lu et al., 2025, Lu et al., 2019, Lamo-Espinosa, 2020, Kim YM, 2023, Bolandnazar et al., 2024, Tangkanjanavelukul et al., 2025, ZoghAli et al., 2025, Mautner et al., 2023, Sun, 2024). One placebo-controlled trial showed lack of efficacy (Bolandnazar et al., 2024), while others suggested efficacy (Kim YM, 2023, Emadedin M, 2018, Vangsness et al., 2014, Farr et al., 2019). A trial comparing with glucocorticosteroid found no differences at 1 year (Mautner et al., 2023), which as there is no efficacy of steroid at one-year, also suggests lack of efficacy. Two trials show lack of superiority to viscosupplementation, which also shows poor evidence of efficacy (see separate guidance) (Boffa et al., 2022, Zaffagnini et al., 2022). One trial of randomizing one knee to arthroplasty and the other to bone marrow concentrate injections in subchondral lesions of the medial condyle and medial tibial plateaus reported delays in arthroplasty (Hernigou et al., 2018). There are many comparative trials with other treatments such as PRP or exercise (Lu et al., 2025, Lu et al., 2019, Lamo-Espinosa, 2020, Tangkanjanavelukul et al., 2025, ZoghAli et al., 2025, Sun, 2024, Gobbi, 2023, Koh YG, 2014, Wong et al., 2013, Saw KY, 2013, Anz et al., 2022, Centeno C, 2018). There also are many low-quality studies, typically with small sample sizes and/or sparse methods (Bastos et al., 2018, Bastos et al., 2020, Delgado-Enciso I, 2018, Song Y, 2018, Lamo-Espinosa et al., 2016, Lamo-Espinosa et al., 2018, Chen et al., 2021, Freitag J, 2019, Freitag, 2024, Garay-Mendoza et al., 2018, Garza et al., 2020, Gupta et al., 2016, Hernigou et al., 2018, Hernigou et al., 2021, Ho et al., 2022, Hong et al., 2019, Hong et al., 2023, Jo et al., 2017, Kim et al., 2022, Lee et al., 2025, Kuah et al., 2018, Lee et al., 2019, Mormone et al., 2025, Vega A, 2015)(Koh YG, 2012)(Ruane et al., 2021, Pers et al., 2016, Sadri et al., 2023, Sajadi S, 2025, Shapiro et al., 2017, Soltani et al., 2019, Turajane et al., 2017, Zhang et al., 2022, Zhao et al., 2024, Matas J, 2019, Kaminski et al., 2019, Louis et al., 2021, Khalifeh Soltani S, 2019, Baria et al., 2022, Baria et al., 2024). There also are approximately twice as many systematic review/metanalysis articles as there are quality RCTs, and there are conflicting conclusions regarding impacts on pain, function, cartilage volume and quality of life. One systematic review concluded that treatment effects were largely attenuated or insignificant when looking at trials with low risk of bias (Sadeghirad et al., 2024). Inconsistent reporting of statistics with biases in the reporting of results between abstracts and the text have been noted (Milan et al., 2025) and a higher proportion of spin bias has also been noted in 80% of studies (Woolley et al., 2025). The higher-quality systematic review concluded: 1) there is a positive effect of autologous mesenchymal stem cell therapy but that nearly all studies have "high" risk of bias, the heterogeneity is so high that it precludes pooled analyses, the overall certainty of the evidence is low to very low, and that this intervention should be reserved for those with insufficient results from other treatments and who are ineligible for arthroplasty (Wiggers et al., 2021). Stem cell therapies are invasive. The literature is highly heterogenous and does not clearly define optimal cells, optimal cell dose, techniques, and approaches. There also is a lack of quality trials with longer-term follow-up. Because the evidence of efficacy substantially conflicts, there are

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some adverse effects, and these therapies are very high cost for a noncurative intervention, stem cell therapy is not recommended (57% of the panel agreed with Not Recommended, whereas 29% agreed with No Recommendation and 14% agreed with Recommended).

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Stromal cells, mesenchymal stromal cells; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 610 articles in PubMed, 45 in CINAHL, 46 in Cochrane Library, 33,000 in Google Scholar, and 0 from other sources†. We considered for inclusion 12 from PubMed, 0 from CINAHL, 6 from Cochrane Library, 0 from Google Scholar, and 1 from other sources. Of the 19 articles considered for inclusion, 13 randomized trials and 6 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

VISCOSUPPLEMENTATION

Viscosupplementation has been used for knee osteoarthrosis [7,832,839-856] and to treat pain after arthroscopy and meniscectomy [857-863].

INTRAARTICULAR KNEE VISCOSUPPLEMENTATION INJECTIONS FOR KNEE OSTEOARTHROSIS

Not Recommended

Intraarticular viscosupplementation injections are not recommended for the treatment of knee osteoarthrosis (43% of the panel agreed with Not Recommended, whereas 43% agreed with No Recommendation and 14% agreed with Recommended). There may be a narrow

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indication for patients who are both not eligible for arthroplasty and for whom there is an inability to perform PRP injections.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Moderately to severe knee osteoarthrosis with insufficient responses to NSAID/acetaminophen, and exercise. Generally, should also have attempted weight loss. Glucocorticosteroid should generally also be trialed first as there is moderate quality evidence suggesting comparable efficacy (Joshi Jubert et al., 2017, Güvendi et al., 2018).

Benefits

Improved pain and function, with somewhat conflicting evidence on duration of the benefit. There may be a narrow indication for patients who are not eligible for arthroplasty, who prefer to delay the need for TKA, or for whom there is an inability to perform PRP injections (Dasa V, 2018, Altman R, 2015).

Harms

Increased risk of infection after arthroplasty (Richardson SS, 2019), allergic reactions, increased pain, and intolerance.

Frequency/Dose/Duration

One injection should be evaluated to ascertain whether it is effective. While a series of injections has been trialed, there is no clear superiority of a series of injections compared with a single injection.

Rationale

Viscosupplementation has been used for the treatment of knee osteoarthrosis, meniscal tears, and other knee disorders (Strand et al., 2015, Altman et al., 2018, Di et al., 2018, Li et al., 2018, Ran et al., 2018, Miller et al., 2020, Tang et al., 2020, Karasavvidis et al., 2021, Chavda et al., 2022, Pereira et al., 2022). There are multiple placebo-controlled RCTs of viscosupplementation (Farr et al., 2019, Kul-Panza et al., 2010, Gramajo et al., 1989, van der Weegen et al., 2015, Lohmander et al., 1996, Karlsson et al., 2002, Lundsgaard et al., 2008, Day et al., 2004, Wobig et al., 1999, Baker et al., 2012, Chevalier et al., 2010, Altman et al., 2004, Altman et al., 2009, DeCaria et al., 2012, Migliore et al., 2021, Arden et al., 2014, Huang et al., 2011, Jorgensen et al., 2010, Petrella et al., 2006, Petterson et al., 2018, Ha et al., 2017, Metsavaht et al., 2024, Hangody et al., 2018, Qvistgaard et al., 2006, Diracoglu et al., 2009, Pham et al., 2004, Brandt et al., 2001) and many of them report lack of efficacy (Pham et al., 2004, Jorgensen et al., 2010, Neustadt et al., 2005, Lundsgaard et al., 2008, Karlsson et al., 2002, Dahlberg et al., 1994, Dixon et al., 1988, Henderson et al., 1994, Arden et al., 2014, van der Weegen et al., 2015). A systematic review with metanalysis concluded

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viscosupplementation shows minor reductions in knee OA pain that is less than the minimal clinically important difference (Pereira et al., 2022). AAOS also recommends against routine use (American Academy of Orthopaedic Surgeons, 2021).

There is one quality trial of injections of PRP vs. Hyaluronic acid vs. NSAID and used MRI imaging, and while the symptoms reportedly improved, there was not evidence of efficacy based on MRI results at one year (Buendía-López et al., 2018). One trial without placebo-control suggested MRI improvements in the PRP group compared with the HA group, with 48% vs. 8% improving at least one OA grade over 12 months (Lisi et al., 2018).

There are many quality comparative trials (Sanchez et al., 2012, Filardo et al., 2012, Cerza et al., 2012, Vaquerizo et al., 2013, Louis et al., 2018, Bains et al., 2025, Bansal et al., 2021, Fossati et al., 2024, Ghorbani et al., 2024, Zhao et al., 2020, Baria et al., 2022, Huang et al., 2022, Kavadar et al., 2015, Nabi, 2018, Park et al., 2021, Raeissadat et al., 2021, Subramanyam et al., 2021, Szwedowski et al., 2022, Tavassoli et al., 2019, Akan, 2018, Zhuang, 2024, Wang et al., 2022, Wu et al., 2022, Yaradilmis et al., 2020, Tang et al., 2020), mostly showing PRP superiority against viscosupplementation. One trial without placebo-control suggested MRI improvements in the PRP group compared with the HA group, with 48% vs. 8% improving at least one OA grade over 12 months (Durmus et al., 2012). Thus, the body of evidence tends to suggest PRP injections tend to be superior to viscosupplementation injections, which appear superior to glucocorticosteroids (see below).

There are many trials comparing viscosupplementation with glucocorticosteroid injection. Most of these trials comparing viscosupplementation with glucocorticosteroid injection suggested glucocorticosteroid injections are inferior for the knee over the intermediate to longer-term (Caborn et al., 2004, Frederico et al., 1990, Frizziero et al., 2002, Guidolin et al., 2001, Leardini et al., 1991, Leighton et al., 2014, Pietrogrande et al., 1991); however, for the hip the reverse may be true (Qvistgaard et al., 2006). One high-quality trial suggested comparable results until 26 weeks at which point the glucocorticoid appeared to be losing benefit while the benefits of the viscosupplementation had greater persistence (Leighton et al., 2014). The next highest quality trial suggested comparable efficacy over 3 months (Qvistgaard et al., 2006, Leighton et al., 2014).

There are reports that viscosupplementation has been associated with modest delays in arthroplasty (Dasa V, 2018, Altman R, 2015). However, without adequate controls the question of quality evidence in delaying need of arthroplasty is challenging to address as there are natural delays in arthroplasty based on the multiple time periods after a series of injections plus the delay between the last injection and arthroplasty.

Thus, the body of evidence suggests PRP injections appear superior to viscosupplementation injections, which appear superior to glucocorticosteroids (see below).

Hyaluronic acid injections are invasive, have moderate adverse effects, are high cost, have mixed efficacy against placebo injections that is below a minimum clinically important difference, have lack of durable efficacy, and have evidence suggesting PRP injections appear superior to hyaluronic acid injections. Thus, viscosupplementation injections are not recommended. Indications are provided for potential very narrow indications (43% of the

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panel agreed with Not Recommended, whereas 43% agreed with No Recommendation and 14% agreed with Recommended). There may be a narrow indication for patients who are both not eligible for arthroplasty and for whom there is an inability to perform PRP injections.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: viscosupplementation, hyaluronic acid; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1306 articles in PubMed, 353 in CINAHL, 49 in Cochrane Library, 17800 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 31 from Google Scholar, and 0 from other sources. Of the 31 articles considered for inclusion, 20 randomized trials and 11 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

GLUCOCORTICOSTEROIDS

Intraarticular glucocorticosteroid injections are frequently performed to attempt to deliver anti-inflammatory medication to the joint with minimal systemic effects [818,819,864-875]. Their usual purpose is to gain sufficient relief to either resume conservative medical management or to delay operative intervention. These injections are generally performed without fluoroscopic or ultrasound guidance. Intraarticular injections have also been utilized intraoperatively at the close of procedures, including meniscectomy [876] and arthroscopy [877,878]. Periarticular injections have been used in arthroplasty patients [879] in an attempt to facilitate recovery.

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INTRAARTICULAR GLUCOCORTICOSTEROID INJECTIONS FOR KNEE OSTEOARTHROSIS

Recommended

Intraarticular glucocorticosteroid injections are selectively recommended for the treatment of knee osteoarthrosis, especially for short-term control of symptoms. However, glucocorticoid injections are also not recommended within 6 months of arthroplasty due to significantly increased risk of infection which may be catastrophic (Kim YM, 2023, Cancienne JM, 2015).

Strength of evidence Recommended, Evidence (C)
Level of confidence Moderate

Indications

Pain from osteoarthrosis sufficient that control with NSAID(s), acetaminophen, weight loss or exercise is unsatisfactory (Raynauld et al., 2003, Gaffney et al., 1995, Ravaud et al., 1999, van Oosterhout et al., 2006). There should be no plan for arthroplasty in the near term.

Benefits

Improved pain and function. Most evidence suggests a duration of benefit of approximately 3 months compared with placebo.

Harms

Rare infections, short-term poorer control of diabetes, focal skin pigmentation fat atrophy changes, and avascular necrosis. One trial found steroid injections were associated with greater cartilage loss over 2-years on MRI scans compared with saline injections (McAlindon et al., 2017). However, there is an increased risk of infected prothesis if an injection is performed within 3-6 months before arthroplasty.

Frequency/Dose/Duration

Only 1 injection should be scheduled and the results assessed. Medications used in RCTs include triamcinolone acetonide 40mg, 80mg, triamcinolone hexacetonide 20mg, betamethasone 6mg, hydrocortisone 25mg, and methylprednisolone 80mg and 120mg) (Raynauld et al., 2003, Gaffney et al., 1995, van Oosterhout et al., 2006). One trial used cortivazol 3.75mg (Ravaud et al., 1999). There was no benefit of 80mg triamcinolone acetonide vs. 40mg (Popma et al., 2015). Extended-release preparations have been suggested to produce a modestly more durable benefit (Conaghan et al., 2018, Bodick et al., 2015). Anesthetics have most often been bupivacaine or lidocaine. Whether aspiration should be performed for effusions in osteoarthrosis patients is unknown; however, there is quality evidence that aspiration of effusions prior to injection results in greater effectiveness for rheumatoid arthritis patients (Weitoft et al., 2000). Many trials included aspiration prior to injection. There is moderate evidence that a superomedial or superolateral approach is superior to a lateral approach (Wind et al., 2004). Bed rest has been used after treatment in rheumatoid arthritis patients to theoretically reduce speed of systemic absorption;

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however, a moderate-quality trial demonstrated no difference and there is no reason to believe the results would be different in osteoarthrosis patients (Weitoft et al., 2005, Weitoft et al., 2006). Thus, post-injection bed rest is not recommended. There is no evidence to suggest limiting the number of injections, and a high-quality trial found both evidence of efficacy of glucocorticoid injections compared to placebo and no evidence of accelerated osteoarthrosis when injected 4 times a year for 2 years (Raynauld et al., 2003). Multiple doses have been utilized in trials with no head-to-head comparisons of dosing regimens. Comparative trials have suggested methylprednisolone acetate 40mg is superior to triamcinolone hexacetonide 20mg, which is superior to betamethasone 6mg (Valtonen, 1981, Pyne et al., 2004). However, those results have not been replicated. Another comparative clinical trial found greater efficacy for methylprednisolone 80mg over 40mg for the hip joint (Robinson et al., 2007).

Indications for discontinuation

A second glucocorticosteroid injection is not recommended if the first has resulted in significant reduction or resolution of symptoms. If there has been no response to a first injection, there is less indication for a second. If it is believed that the medication was not well placed and/or if the underlying condition is so severe that one steroid bolus could not be expected to adequately treat the condition, a second injection may be indicated. In patients who demonstrates a pharmacologically appropriate response consisting of several weeks of temporary, partial relief of pain, but who then have worsening pain and function and who are not (yet) interested in surgical intervention, a repeat steroid injection is an option. Benefits beyond approximately 4 injections per year are not thought to exist (Raynauld et al., 2003). Patients requesting more injections should have reassessment of conservative management measures and be evaluated for irrigation/lavage and surgical intervention.

Rationale

Intraarticular glucocorticosteroid injections have been used for the treatment of knee osteoarthrosis (Smith et al., 2019, Tian et al., 2018, Saltychev et al., 2020, Ayub et al., 2021, McLarnon et al., 2021, Najm et al., 2021, Testa et al., 2021). There are many high- and moderate-quality RCTs evaluating efficacy of glucocorticosteroid injections compared to placebo for treatment of knee OA (Hasso et al., 2004, Dieppe et al., 1980, Jones et al., 1996, Miller et al., 1997, Friedman et al., 1980, Cederlof et al., 1966). These have nearly uniformly found efficacy (however, the magnitude and duration of benefits compared with placebo is only ~ 3 months (Saltychev et al., 2020), thus the reduction in the evidence based rating to “C”) (Raynauld et al., 2003, Gaffney et al., 1995, Young et al., 2001, Ravaud et al., 1999). Moderate-quality trials have suggested viscosupplementation is superior to glucocorticoid injection over a longer term (Caborn et al., 2004, Frizziero et al., 2002, Leardini et al., 1991). There are many low quality trials (Bellamy et al., 2016, Brumini et al., 2025, Damjanov et al., 2023, Davis et al., 2018, Popma et al., 2015, Forogh et al., 2016). One trial showed cartilage loss over 2 years compared with saline (McAlindon et al., 2017).

Comparative trials have suggested superiority of physical therapy exercises at 1 year of follow-up (Deyle et al., 2020, Lee et al., 2025), no additive benefit of steroid to exercise

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therapy (Henriksen et al., 2015, Soriano-Maldonado et al., 2016), comparability to ketorolac injection (Jurgensmeier et al., 2021), superiority of PRP at 1 year (Elksniņš-Finogejevs et al., 2020), comparability with hyaluronic acid injection (Hangody et al., 2018). Comparative trials show no differences between different steroids (Kumar et al., 2017) and that triamcinolone 10mg was non-inferior to 40 mg (Utamawatin et al., 2023). One trial suggested intramuscular injection is inferior to intraarticular (Wang et al., 2022).

Intraarticular glucocorticosteroid injections are invasive, have a low risk of adverse effects (other than before arthroplasty), are moderately costly, have evidence of short- to intermediate-term efficacy, and are selectively recommended for treatment of moderate-to severe osteoarthrosis patients, particularly after inadequate results from NSAIDs, acetaminophen, exercise, or other non-invasive interventions. As there is quality evidence of progression of the loss of articular cartilage compared with saline injections, these should generally be reserved for advanced cases (McAlindon et al., 2017), and should not be performed within 6 months of arthroplasty.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Intra-articular injections, glucocorticosteroids; osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 187 articles in PubMed, 46 in CINAHL, 41 in Cochrane Library, 17,300 in Google Scholar, and 0 from other sources†. We considered for inclusion 27 from PubMed, 3 from CINAHL, 0 from Cochrane Library, 5 from Google Scholar, and 0 from other sources. Of the 35 articles considered for inclusion, 26 randomized trials and 8 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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TIDAL KNEE JOINT IRRIGATION

Large-volume irrigation of the knee joint has been used for treatment of knee osteoarthrosis [814,815,816]. Intraarticular glucocorticosteroid injections are frequently given simultaneously. This procedure may be performed in conjunction with arthroscopy, although it has also been performed without arthroscopy.

TIDAL KNEE JOINT IRRIGATION FOR KNEE OSTEOARTHROSIS

Not Recommended

Tidal knee joint irrigation is not recommended for the treatment of knee osteoarthrosis.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

One sham-controlled trial suggested a lack of efficacy, although the randomization process failed and they attempted statistical adjustment (Bradley et al., 2002). There are three moderate-quality RCTs comparing the efficacy of tidal irrigation to glucocorticosteroid injection for treatment of knee OA, with all 3 trials finding evidence of superiority of irrigation to injection (Arden et al., 2008, Ravaud et al., 1999, van Oosterhout et al., 2006). Two of the trials comparing the two procedures found superiority for patients undergoing irrigation followed by glucocorticoid injection (Ravaud et al., 1999, van Oosterhout et al., 2006). One trial suggested superiority compared with conservative medical management (Ike 92). These procedures are invasive, have adverse effects, are moderate to high cost, the single sham-controlled trial suggests a lack of efficacy, and therefore, tidal irrigation is not recommended.

Adjunctive treatment with glucocorticosteroids after lavage has been assessed in many studies with mixed results. Both the highest quality study (Smith et al., 2003) and the largest trial (Frias et al., 2004) were largely negative and thus it is not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Tidal Irrigation, joint irrigation, knee irrigation, knee lavage; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 191 articles in PubMed, 9 in CINAHL, 13 in Cochrane Library, 2,510 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those

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prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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PROLOTHERAPY

Prolotherapy injections attempt to address a theoretical cause or mechanism for chronic pain. This therapy involves repeated injections of irritating, osmotic, and chemotactic agents (e.g., dextrose, glucose, glycerin, zinc sulphate, phenol, guaiacol, tannic acid, pumice flour, sodium morrhuate) combined with an injectable anesthetic agent to reduce pain, into knee structures, especially knee and other ligaments, with the theoretical construct that it will strengthen these tissues.

PROLOTHERAPY INJECTIONS FOR KNEE PAIN

Not Recommended

Prolotherapy injections are not recommended for treatment of acute, subacute, or chronic knee pain.

Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

Prolotherapy injections have been used for the treatment of knee pain (Hung et al., 2016, Sit et al., 2016, Krstičević et al., 2017, Arias-Vázquez et al., 2019, Rezasoltani et al., 2020, Chen et al., 2022, Cortez et al., 2022, Waluyo et al., 2023, Wang et al., 2022). There are few placebo-controlled studies of prolotherapy injections for treatment of patients with knee OA (Rabago, 2013, Rabago et al., 2015, Sit et al., 2020, Teymouri et al., 2025, Hsieh et al., 2022)(Reeves et al., 2000). RCT evidence has significant methodological weaknesses and substantially conflicts, with some studies suggesting reductions in pain (Rabago, 2013, Rabago et al., 2015) and others suggesting either lack of efficacy (Hsieh et al., 2022, Reeves et al., 2000, Teymouri et al., 2025) or minimal differences (Sit et al., 2020). One trial suggests inferiority to PRP injections (Rahimzadeh et al., 2018). There are comparative trials of one method of prolotherapy vs another (Farpour et al., 2017, Öztürk et al., 2023, Bayat et al., 2023), including one suggesting no differences in efficacy comparing intra-articular with

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peri-articular prolotherapy injections (Farpour et al., 2017), further raising questions about mechanism/utility of prolotherapy. There also are multiple low-quality trials (Ebnerasooli et al., 2024, Eslamian, 2015, Fu et al., 2024, Hashemi et al., 2015, Pishgahi et al., 2020, Singh et al., 2025, Rezasoltani et al., 2017, Yildiz et al., 2023). Prolotherapy injections are invasive, have adverse effects, moderately to highly costly, depending on numbers of injections, have mostly negative placebo-controlled studies, and thus they are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Prolotherapy, prolotherapy injections; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 90 articles in PubMed, 40 in CINAHL, 14 in Cochrane Library, 2,250 in Google Scholar, and 0 from other sources†. We considered for inclusion 23 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 24 articles considered for inclusion, 24 randomized trials and 10 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

BOTULINUM

Botulinum injections have antinociceptive properties and have been used to produce muscle paresis [880,881,882,883]. These injections have primarily been used for non-occupational conditions such as cervical dystonia [884], strabismus, blepharospasm [885], and severe primary axillary hyperhidrosis [885,886]. In the lower extremities, there are treatments that have been used mainly for children with spasticity due to cerebral palsy [887,888,889]. These injections are thought to directly treat a taut muscle band and to have analgesic properties [881,882,883].

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BOTULINUM INJECTIONS FOR KNEE OSTEOARTHROSIS OR OTHER KNEE DISORDERS

Not Recommended

Botulinum injections for knee osteoarthrosis or other knee disorders are not recommended.

Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

Botulinum injections have been used for the treatment of knee osteoarthrosis and other knee disorders (Ismiarto et al., 2023, Sconza et al., 2023, Wang et al., 2023, Lei et al., 2025). There are multiple randomized trials and somewhat conflicting evidence of efficacy (McAlindon et al., 2017, Arendt-Nielsen et al., 2017, Hsieh et al., 2016, Bao et al., 2018, Boon et al., 2010). The highest quality study suggests lack of efficacy (McAlindon et al., 2017). Other trials have heterogeneity and problems with trends towards non-comparability at baseline, making interpretations difficult (Mendes et al., 2019, Singh et al., 2010, Singer et al., 2011, Arendt-Nielsen et al., 2017). One trial was attempted in patients with refractory painful knee after arthroplasty (Singh et al., 2010); however, baseline differences and some nonsignificant results make interpretation challenging. One small trial attempted to treat refractory anterior knee pain, reported significant baseline differences, and suggested some limited improvements (Singer et al., 2011).

A systematic review with meta-analysis concluded there was a lack of efficacy in the knee joint (Gagnière et al., 2025).

Botulinum injections are invasive, have adverse effects including deaths (Li et al., 2005), are costly, lack clear evidence of efficacy with the highest quality evidence suggesting lack of efficacy, and thus they are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: botulinum injections OR botulinum toxin injection; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 52 articles in PubMed, 12 in CINAHL, 7 in Cochrane Library, 2970 in Google Scholar, and 0 from other sources†. We considered for inclusion 7 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 5 from Google Scholar, and 0 from other sources. Of the 10 articles considered for inclusion, 5 randomized trials and 5 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and

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Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

INTERLEUKIN-1 RECEPTOR ANTAGONISTS

Interleukin-1 receptor antagonists have been used to treat rheumatoid arthritis. They have been investigated for treatment of osteoarthrosis [890,891].

INTERLEUKIN-1 RECEPTOR ANTAGONISTS FOR KNEE OSTEOARTHROSIS

Not Recommended

Interleukin-1 receptor antagonists are not recommended for treatment of osteoarthrosis.

Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

Interleukin-1 receptor antagonists have been used for the treatment of knee osteoarthrosis (Ajrawat et al., 2019, Knapik et al., 2024). There are three quality RCTs that suggest a lack of efficacy (Fleischmann et al., 2019, Chevalier et al., 2009, Yang et al., 2008), although one with negative primary outcomes measures suggested slight benefits in some secondary outcome measures (Auw Yang et al., 2008). Taken together, these results suggest a lack of efficacy and thus, interleukin-1 receptor antagonists are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Interleukin 1 receptor antagonist protein, IL1RN protein, IL-1Ra OR Anakinra, IL-1 Inhibitor, Febrile Inhibitor; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 82 articles in PubMed, 13 in CINAHL, 5 in Cochrane Library, 5990 in Google Scholar, and 0 from other sources†. We considered for inclusion 4 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 4

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articles considered for inclusion, 2 randomized trials and 2 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

OTHER INJECTIONS

SPRIFERMIN FOR KNEE OSTEOARTHROSIS

No Recommendation

There is no recommendation for or against sprifermin (FGF-18), which has not been approved by the U.S. Food and Drug Administration (FDA).

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Sprifermin (FGF-18) has been used for the treatment of knee osteoarthrosis (Zeng et al., 2021). Intraarticular sprifermin, a recombinant human fibroblast growth factor 18, has been studied by one research group for the treatment of knee osteoarthrosis. Their sizable, dose-ranging, placebo-controlled trials have suggested some evidence of dose-response increases in cartilage thickness and reduced losses (Lohmander et al., 2014). Post-hoc reports have showed trends toward efficacy using endpoints of both symptoms and MRI (Eckstein, 2015, Eckstein et al., 2020, Eckstein et al., 2021, Roemer et al., 2016, Roemer et al., 2020, Hochberg et al., 2019, Guehring et al., 2021, Conaghan et al., 2025). Sprifermin is minimally invasive, has adverse effects, is high cost, and has some data suggesting efficacy, but it is not yet FDA-approved. Thus, there is no recommendation for or against its use.

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Sprifermin FGF-18, Sprifermin, rhFGF18; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 14 articles in PubMed, 8 in CINAHL, 13 in Cochrane Library, 843 in Google Scholar, and 0 from other sources†. We considered for inclusion 9 from PubMed, 0 from CINAHL, 3 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 12 articles considered for inclusion, 11 randomized trials and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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GENICULAR ARTERY EMBOLIZATION FOR KNEE OSTEOARTHROSIS

Not Recommended

Genicular artery embolization is not recommended for treatment of knee osteoarthrosis.

Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

Genicular artery embolism has been used for the treatment of knee osteoarthrosis (Casadaban et al., 2021, Torkian et al., 2021, Bhatia et al., 2023, Epelboym et al., 2023, Taslakian et al., 2023, Chlorogiannis et al., 2024, Abussa et al., 2025, Berreta et al., 2025, Hernández-Yumar et al., 2025, Milhem et al., 2025). Two sham-controlled trials both suggest lack of efficacy (van Zadelhoff et al., 2024, Landers et al., 2023). There are no quality comparative trials. Multiple low-quality and excluded studies had problems including small sample sizes and other methodological issues (Bagla et al., 2020, Little et al., 2024). By contrast, systematic reviews found evidence of short-term efficacy in the literature with

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considerable heterogeneity, although most of that literature base is low quality (Milhem et al., 2025, Torkian et al., 2021, Berreta et al., 2025).

Genicular artery embolization is invasive, has adverse effects, and is high cost. With quality sham-controlled trials showing lack of efficacy, it is not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: genicular artery embolization, knee embolization; osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 226 articles in PubMed, 5 in CINAHL, 26 in Cochrane Library, 1,310 in Google Scholar, and 0 from other sources†. We considered for inclusion 167 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 17 articles considered for inclusion, 11 randomized trials and 6 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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TPX-100-5 FOR KNEE OSTEOARTHROSIS

No Recommendation

There is no recommendation for or against TPX-100-5 for the treatment of knee osteoarthrosis.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

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A placebo-controlled trial of TPX-100-5, which is a promotor of osteoblast and chondroblast differentiation, for the treatment of knee OA showed findings consistent with disease modification (McGuire et al., 2021). TPX-100-5 is minimally invasive, has adverse effects, is high cost, and has some data suggesting efficacy, but it is not yet FDA-approved. Thus, there is no recommendation for or against its use.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: TPX-100 peptide injections; knee Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 3 articles in PubMed, 0 in CINAHL, 0 in Cochrane Library, 82 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trial and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

TRAUMEEL AND ZEEL (TR14 AND ZE14) FOR KNEE OSTEOARTHROSIS

Not Recommended

Traumeel and Zeel (Tr14 and Ze14) are not recommended for treatment of knee OA.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Moderate

Rationale

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One trial suggested pain relief (Lozada et al., 2017). However, the FDA issued warning letters in June 2020 that these injections are unapproved drugs, misbranded, and that they contain mercury which could be harmful. Thus, they are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Traumeel, Traumeel S, Tr14, Zeel, Ze14; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 11 articles in PubMed, 0 in CINAHL, 40 in Cochrane Library, 65 in Google Scholar, and 1 from other sources†. We considered for inclusion 2 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 2 articles considered for inclusion, 1 randomized trial and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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SURGICAL CONSIDERATIONS

CHONDROPLASTY AND DEBRIDEMENT

Chondroplasty and debridement have been used to treat knee osteoarthrosis [892,893,894].

KNEE DISTRACTION

KNEE JOINT DISTRACTION FOR KNEE OSTEOARTHROSIS

Not Recommended

Knee joint distraction is not recommended for treatment of knee osteoarthrosis.

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Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

There are few quality trials of knee distraction for surgical treatment of knee osteoarthrosis. The available data suggest comparable outcomes with high tibial osteotomy over 1-5 years of follow-up (Jansen et al., 2021, van der Woude et al., 2017, van der Woude et al., 2017), although only 20 cases were included. A systematic review also found limited evidence of efficacy based on a combined cohort of 127 patients (Jansen et al., 2021). Therefore, knee joint distraction is not recommended for the treatment of knee osteoarthrosis because larger RCTs with longer follow-up durations are needed.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Knee joint distraction; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 20 articles in PubMed, 28 in CINAHL, 4 in Cochrane Library, 20,300 in Google Scholar, and 1 from other sources†. We considered for inclusion 4 from PubMed, 0 from CINAHL, 1 from Cochrane Library, 0 from Google Scholar, and 1 from other sources. Of the 6 articles considered for inclusion, 3 randomized trials and 3 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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CARTILAGE GRAFTS

Cartilage grafts and/or transplantations for osteochondral defects are used for treatment of articular cartilaginous defects [437,895-929]. These procedures are technically difficult and require specific physician expertise. They are thought to be effective in select patients generally less than 40 years old with active lifestyles having a traumatically induced, modest sized cartilage defect. These procedures are believed to delay or possibly prevent the development of osteoarthrosis. However, a Cochrane review concluded there was insufficient evidence, opining that long-term studies are needed [908,930].

CARTILAGE GRAFTS FOR KNEE OSTEOARTHROSIS

Sometimes Recommended

Cartilage grafting and transplants are moderately recommended for select patients with knee osteoarthrosis.

Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Moderate

Indications

Select patients less than 40 years old with active lifestyles with a single, traumatically caused Grade III or IV femoral condyle deficit (Saris et al., 2008, Saris et al., 2009). Deficit diameter recommended not to generally exceed 20mm for osteochondral autograft transplants, although criteria up to 4cm2 has been used. Grafts and transplants not recommended for those with obesity, inflammatory conditions or osteoarthrosis, other chondral defects, associated ligamentous or meniscus pathology, or who are older than 55 years of age. Delayed treatment has been suggested to worsen outcomes (Vanlauwe et al., 2011).

Rationale

Knee articular cartilage transplantation is used to treat focal, full-thickness cartilage defects that do not heal reliably on their own. Techniques include autologous chondrocyte implantation (ACI) and matrix-induced chondrocyte implantation (MACI), in which a patient's own cartilage cells are harvested, expanded in culture, and then re-implanted into the defect, either beneath a membrane (classic ACI) or on a scaffold (MACI). Compared with marrow stimulation procedures such as microfracture, ACI and MACI demonstrate higher success rates and are commonly selected for larger lesions (Vanlauwe et al., 2011, Saris et al., 2008, Saris et al., 2014, Saris et al., 2009, Kish G, 2004, Dozin et al., 2005, Bentley et al., 2003, Bentley G, 2012, Brittberg et al., 2018, Randsborg et al., 2016, Niemeyer et al., 2019, Chen et al., 2025, Clavé A, 2016, Gracitelli et al., 2016).

In contrast, tissue-based cartilage transplantation replaces the damaged area using osteochondral grafts that include both cartilage and underlying bone. Osteochondral autograft transplantation (OAT/mosaicplasty) transfers plugs of cartilage-bone from a low-load area of the patient's own joint into the defect, offering immediate structural fill and typically favorable results for small to medium-sized lesions, though donor-site morbidity can limit the amount of tissue available. Osteochondral allograft transplantation (OCA) uses

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size-matched donor grafts and is often successfully used for larger defects, complex cases, or when prior cartilage procedures have failed (Solheim E, 2018, Bentley et al., 2003, Bentley G, 2012, Kish G, 2004, Dozin et al., 2005, Clavé A, 2016, Ulstein et al., 2014, Gracitelli et al., 2016).

There are no sham-controlled trials. However, there are quality trials that have compared different management approaches for these cartilaginous defects (Knutsen et al., 2004, Knutsen et al., 2007, Van Assche et al., 2010, Saris et al., 2008, Saris et al., 2009)(Saris et al., 2014, Brittberg et al., 2018, Vanlauwe et al., 2011, Chen et al., 2025, Niemeyer et al., 2019). One trial with multiple reports suggests that at up to 10 years, autologous osteochondral transplantation is superior to microfracture in competitive athletes (Gudas et al., 2005, Gudas et al., 2006, Gudas et al., 2012) and another trial by the same author also found superiority when performed in conjunction with ACL reconstruction (Gudas et al., 2013). A different research group also reported evidence suggesting modest superiority of autologous chondrocyte implantation (Niemeyer et al., 2019). One trial reported superiority of mosaicplasty to microfracture at 15-17 years of follow-up (Solheim E, 2018). Systematic reviews have reported overall graft survival of 78.7% at 10 years (Familiari et al., 2018)(Pareek A, 2016), equivalency between autologous chondrocyte implantation and osteochondral autograft transfer (Mundi R, 2016), superiority to microfracture (Zamborsky R, 2020)(Angele P, 2022), and cost-effectiveness for femoral condylar lesions, but not patellofemoral or bipolar, and superiority to microfracture (Everhart et al., 2020).

Trials have included rigorous enrollment criteria that have on at least one occasion only included conditioned athletes (Gudas et al., 2005). There are increasing numbers of longer term studies that have followed treated patients from 3-10 years (Gudas et al., 2005, Behrens et al., 2006, Gudas et al., 2006, Micheli et al., 2001, Gudas et al., 2012, Gudas et al., 2013) that have reported persistent benefits. Further studies with long follow-ups and larger sample sizes are needed.

Meniscal allografts (i.e., cadaveric menisci) have also been used and reported in case series (Smith et al., 2016, Samitier et al., 2015)(Tan KSA, 2023, Dzidzishvili L, 2025). RCT data are sparse and include a pilot comparative study that was partially randomized to non-operative with 12 months of follow-up suggesting both lack of superiority while also reporting high adverse events in the transplantation group (Smith et al., 2018). RCT data are insufficient in quality, number and extent of follow-ups for a supportive evidence-based recommendation regarding meniscal allografts, and thus the procedure is not recommended pending publication of sizable, supportive RCTs.

Both chondrocyte-based and tissue-based cartilage transplantation techniques have demonstrated clinical efficacy. Mosaicplasty has been not shown to be inferior to microfracture (Everhart 2021; Gracitelli 2016) and is selectively recommended for the treatment of cartilage defects.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Cartilage grafts;

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Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 213 articles in PubMed, 20 in CINAHL, 17 in Cochrane Library, 18,200 in Google Scholar, and 3 from other sources†. We considered for inclusion 11 from PubMed, 1 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 3 from other sources. Of the 15 articles considered for inclusion, 3 randomized trials and 12 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

CHONDROPLASTY AND DEBRIDEMENT FOR KNEE OSTEOARTHROSIS

Not Recommended

Chondroplasty and debridement are moderately not recommended for treatment of knee osteoarthrosis. Note that this recommendation does not apply to removal of detached fragments which are selectively recommended.

Strength of evidence Moderately Not Recommended, Evidence (B)
Level of confidence Moderate

Rationale

A high-quality, sham-controlled trial suggested there is no benefit of chondroplasty and debridement for treatment of knee osteoarthrosis (Moseley et al., 2002). A second trial suggested debridement was not helpful in comparison with joint lavage (Chang et al., 1993). Another trial comparing debridement with observation for unstable chondral lesions found during meniscectomy reported no benefits of debridement at either 1 or 5 years (Bisson et al., 2017, Bisson et al., 2021). One substantially lower-quality trial provided conflicting evidence regarding how debridement compared with lavage (Hubbard, 1996). Other trials

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evaluating electrocautery and radiofrequency treatments suggest no benefits (Kang et al., 2008, Stein et al., 2002). A moderate-quality trial with significant baseline differences between groups was interpreted as suggesting radiofrequency chondroplasty was superior to mechanical for grade III cartilage lesions of the medial femoral condyle, yet the baseline differences were marked and as the substantially worse group at baseline was the mechanical group, the results are effectively uninterpretable (Spahn et al., 2016). Thus, the higher quality trials and balance of evidence indicate that chondroplasty and debridement are ineffective and are not recommended for treatment of knee osteoarthrosis. However, there are lesions that are thought to be mechanical in nature and may require debridement, typically in the context of arthroscopic evaluation of meniscal tears and foreign bodies with mechanical symptoms.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: chondroplasty, debridement; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 5 articles in PubMed, 50 in CINAHL, 0 in Cochrane Library, 1350 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 4 from Google Scholar, and 0 from other sources. Of the 4 articles considered for inclusion, 3 randomized trials and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ARTHROPLASTY

Knee arthroplasty has been long used for treatment of end-stage knee degenerative joint disease. Outcomes have generally been excellent with 5- to 10-year survival rates of 95 to

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99% [931-942]. A modestly worse prognosis including higher infection rates has been reported in rheumatoid arthritis patients [942,943] and among smokers [944]. Unicompartmental arthroplasty has been used for medial joint arthrosis. However, patellar resurfacing is controversial [945].

Pain and functional loss have been shown to be predictors of arthroplasties [946,947] ($p < 0.0001$), as have visual analog scale ratings. Primary reasons for surgical failure are loosening, as well as infected, prostheses. Other predictors of suboptimal results include presence of effusion [948], failure to attend preoperative education [949], older age [950] more pre-operative debility [950,951], longer duration of disease [948], depressive symptoms [952], helplessness [953] and catastrophizing [952,954,955]. Similar to all arthroplasties, the literature has advanced more slowly than the technology resulting in challenges in analyzing the literature for purposes of evidence-based guidance.

Patellar resurfacing has been used to attempt to reduce anterior knee pain that sometimes persists after arthroplasty. Randomized trials have shown lack of clear short- or long-term benefits [956-989] and systematic reviews and meta-analyses have concluded that while there are fewer reoperations for anterior knee pain among those who were randomized to receive patellar resurfacing at the time of arthroplasty, there is no clear advantage of including that operative procedure in an arthroplasty [990,991,992,993,994]. The AAOS Guidelines also indicate there is no demonstrable benefit attributable to resurfacing in the randomized trials [995]. A study with 20-year follow-up concluded that the primary outcomes were not different, but resurfacing was associated with higher quality-of-life scores [996]. Thus, as there is no clear benefit of patellar resurfacing during arthroplasty, thus patellar resurfacing is generally not indicated as it adds costs and potential complications. There may be individualization needed if, e.g., the patient has a large component of anterior knee pain. Patellar denervation at the time of arthroplasty has also been used to attempt to address these problems, but has not been proven successful in most studies [997-1005].

Remotely, high tibial osteotomy was performed for medial compartment cases especially in younger individuals who may continue to be candidates for that procedure [1006]. However, with advancements in unicompartmental arthroplasties and total joint arthroplasties, it has become much less common in the United States.

KNEE ARTHROPLASTY FOR MODERATE TO SEVERE ARTHRITIDES

Recommended

Knee arthroplasty is strongly recommended for severe knee arthritides.

Strength of evidence Strongly Recommended, Evidence (A)
Level of confidence High

Indications

Surgical indications are all of: 1) knee joint osteoarthrosis symptoms for at least 6 months; 2) sufficient symptoms and functional limitations, such as impairments of activities of daily living and/or occupational tasks; 3) significant/severe knee degenerative joint disease on imaging; and 4) unresponsive or insufficiently responsive to nonoperative treatments including exercise, medications, activity modification and a trial of weight loss if indicated

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(though failure should not be used to deny TKA for patients who otherwise merit surgery) for a period of 6 months.

Benefits

Restoration of normal knee functions.

Harms

Thromboembolic phenomenon, myocardial infarction, peroneal nerve injury, inability to fully recover function (e.g., often due to lack of full effort in rehabilitation and with functional exercises), arthrofibrosis, rare deaths, infections, seroma, rare amputations typically for unresolvable infectious complications. Complication rates are higher among those with rheumatoid arthritis (Qiao et al., 2023) and among smokers. Risk factors for chronic postoperative pain include age, BMI, prior knee surgeries, comorbidities, adverse health beliefs, sleep disorders, central sensitization, anxiety, depression, and a poor preoperative functional level (Li et al., 2024, Li et al., 2025). Risk of periprosthetic infection is twice that in patients with rheumatoid arthritis compared with osteoarthrosis (Lee et al., 2018). Increased BMI is associated with lower post-operative physical function (Olsen et al., 2023). One review noted the most common predictors of dissatisfaction were preoperative anxiety or depression (Kahlenberg et al., 2018).

Rationale

Numerous trials of arthroplasty have been performed (Skou et al., 2015)(Hilding et al., 1997, Hilding et al., 1995, Masri et al., 1996, Kim et al., 2009, Kim et al., 2009, Nutton et al., 2008, Harato et al., 2008, Chaudhary et al., 2008, Tanzer et al., 2002, McCalden et al., 2009)(Uvehammer et al., 2001, Weeden et al., 2007, Matsuda et al., 2005, Matsumoto et al., 2009, Saari et al., 2006, Shoji et al., 1994, Snider et al., 2009, Lee et al., 2005, Swanik et al., 2004, Ishii et al., 2008, Aigner et al., 2004, Beard et al., 2007, Price et al., 2003, Hasegawa et al., 2009, Munro et al., 2010, Kim et al., 2004, Kim et al., 2005, Kim et al., 2007, Kim et al., 2001, Breugem et al., 2008, Gioe et al., 2009, Gleeson et al., 2004, Hansson et al., 2005, Harrington et al., 2009, Henricson et al., 2006, Ladermann et al., 2008, Li et al., 2006, Seon et al., 2009, Wylde et al., 2008, Confalonieri et al., 2004, Pagnano et al., 2004, Aglietti et al., 2005, Garling et al., 2005, Wohlrab et al., 2009, Saari et al., 2003, Gao et al., 1995, Reiter et al., 2003, Tarradell et al., 1996, Grattidge, 1998, Toksvig-Larsen et al., 1994)(Pandit et al., 2009, Reed et al., 2002, Carpiniello et al., 1988, Hansson et al., 2009, Usichenko et al., 2008, Levy et al., 1993, Andersen et al., 2008, Webb et al., 1998, Berti et al., 1997, Hester et al., 1992, Maruyama et al., 2004, Gioe et al., 2000, Gioe et al., 2006, Higuchi et al., 2009, Ishii et al., 2005, Toksvig-Larsen et al., 2000, Baker et al., 2007, Khaw et al., 2002, Nilsson et al., 1993, Nilsson et al., 1991, Nilsson et al., 1995, Regner et al., 1999, Ensini et al., 2007, Park et al., 2007, Brown et al., 1996, Healy et al., 1994, Kirk et al., 1994, Laskin, 2003, Laskin et al., 2000, Linke et al., 2006, Michelson et al., 1988, Parker et al., 2001, Stern et al., 1994, Wallace et al., 2012)(Johnston et al., 2009). There is one trial that compared arthroplasty or other surgical procedures with non-operative management and showed superiority of arthroplasty (Skou et al., 2015). A Cochrane review was based on one study and concluded that compared to a non-surgical program alone, TKA followed by a nonsurgical program may

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reduce pain at a level that is clinically important; may improve physical function at a level that is not clinically important; and may reduce the need for follow-up knee surgery (Pacheco-Brousseau L, 2026). All of the many other quality comparative trials have reported marked improvements in all surgical arms of the trials; thus, arthroplasty is strongly recommended for select patients who fail nonoperative management.

For largely unicompartmental disease, one moderate-quality trial has reported 5- and 15-year follow-ups and found better range of motion and “excellent” results with unicompartmental arthroplasty compared with total joint arthroplasty (Newman et al., 1998, Newman et al., 2009). Thus, unicompartmental arthroplasty is recommended for that select group of patients. One trial has compared high tibial osteotomy with unicompartmental arthroplasty and found that arthroplasty resulted in a longer time to failure, as defined as total joint arthroplasty, but most results were reasonably comparable (Roysam et al., 2001), thus high tibial osteotomy also remains as a reasonable option especially for younger patients" (Santoso MB, 2017).

There are several trials of surgical approaches, but data somewhat conflict. A quadriceps sparing or subvastus approach has been found to result in superior short-term results or trends towards superiority in most (Roysam et al., 2001, Karachalios et al., 2008, Juosponis et al., 2009, Bäthis et al., 2005) but not all trials (Aglietti et al., 2006). Two older trials were negative (Faure et al., 1993, Carlsson et al., 2006). A mini-incision medial parapatellar approach has also been found to be associated with a shorter hospital stay in one trial (Carlsson et al., 2006), but was not found to be superior to a quadriceps sparing approach in another trial (Lin, 2009). As there are minimal differences in outcomes, there is no recommendation, although the subvastus approach has some evidence of very short-term superiority.

Various computer navigation and robotic systems have been reported in many studies and quality trials (Park et al., 2007, Choong et al., 2009, Confalonieri et al., 2007, Cobb et al., 2006, Stockl et al., 2004, Oberst et al., 2008, Kalairajah et al., 2006, Dutton et al., 2008, van Strien et al., 2009, Chin et al., 2005, Sparmann et al., 2003, Hall et al., 2008, Hurschler et al., 2008, Kim et al., 2008). Short-term results include better function (Dutton et al., 2008), worse function (Weinrauch et al., 2006), no differences in outcomes (Clement et al., 2023), and no differences in fat emboli (Kim et al., 2008). All trials that have reported on alignment found superior anatomic alignment with those systems. Superior alignment is presumed to result in superior outcomes long-term; however, to date only one trial has reported some results suggesting better outcomes at 1 year (Choong et al., 2009). While the reduction in malposition is hopeful, the increased cost and the lack of data to support a change in failure rate result in no formal recommendation for or against those systems.

Different prosthetic designs have been reported in quality trials (Hyldahl H, 2005, Hyldahl et al., 2005, Mattsson et al., 2005, Norgren et al., 2004, Muller et al., 2006, Adalberth et al., 2001, Adalberth et al., 2000, Hyldahl et al., 2001, Bettinson et al., 2009, Nilsson et al., 1998). Components have also been coated, uncoated, cemented and uncemented (Onsten et al., 1998, Carlsson et al., 2005, Nilsson et al., 2006, Nilsson et al., 1999, Nelissen et al., 1998, Beaupre et al., 2007, Uvehammer et al., 2007, Regner et al., 2000, Regner et al., 1998, Hansson et al., 2008, Petersen et al., 2005, Gao et al., 2009, Dalen et al., 2005, Hilding et al.,

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2000, Dunbar et al., 2009, Toksvig-Larsen et al., 1998, van der Linde et al., 2006, Albrektsson et al., 1992, Clarke et al., 1998, McCaskie et al., 1998, Saari et al., 2009). Quality trials demonstrating clear superiority of one design over another are not reported. Cemented prostheses tend to migrate less in the short term, but over the intermediate term, cemented prostheses migrate equivalent amounts, and longer term results are unclear comparing the two options.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Knee arthroplasty or Total knee arthroplasty; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2309 articles in PubMed, 11 in CINAHL, 27 in Cochrane Library, 17 700 in Google Scholar, and 14 from other sources†. We considered for inclusion 25 from PubMed, 1 from CINAHL, 0 from Cochrane Library, 10 from Google Scholar, and 14 from other sources. Of the 50 articles considered for inclusion, 13 randomized trials and 37 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

RADIATION SYNOVECTOMY

Radiation synovectomy has been used for treatment of patients with knee arthritis, although mostly among those thought to have an inflammatory component or undifferentiated arthritis [818,819].

RADIATION SYNOVECTOMY FOR KNEE OSTEOARTHROSIS

Not Recommended

Radiation synovectomy is not recommended for the treatment of knee osteoarthrosis.

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Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

A moderate-quality trial comparing radiation synovectomy with glucocorticoid injection with a radiation sham plus glucocorticoid suggested that radiation synovectomy was ineffective for treatment of undifferentiated arthritis and rheumatoid arthritis (Jahangier et al., 2005, Jahangier et al., 2006). Radiation synovectomy is invasive, has adverse effects, is moderately costly, appears ineffective, and is not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Radiation synovectomy, RSV; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 5 articles in PubMed, 0 in CINAHL, 1 in Cochrane Library, 2580 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

REHABILITATION PROGRAMS

Numerous studies have evaluated postoperative rehabilitation and activity levels that appear important for recovery from knee procedures, especially for arthroplasty [1007,1008]. Considerations have included preoperative exercise programs, postoperative activity limitations, postoperative rehabilitation programs, and late rehabilitation programs several months after surgery [1009,1010]. Compliance is noted to be problematic.

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PREOPERATIVE EDUCATION

Educational interventions have been used for rehabilitation of arthroplasty patients, particularly for preoperative preparation [1011,1012,1013]. These interventions may include various combinations of procedural, sensory information, cognitive coping strategies, reassurance, and relaxation and hypnosis training [1014,1015]. Multiple modes of instruction are frequently incorporated, including oral, written, and video.

PREOPERATIVE EDUCATIONAL PROGRAM PRIOR TO ARTHROPLASTY

Recommended

A preoperative educational program is recommended prior to arthroplasty. Components are recommended to include procedural and recovery information, using at least two modes of teaching (e.g., oral and written). It may also be included as part of "prehab." Discussions may include postoperative opioid sparing pain control, realistic expectations for improvements in pain and function (including return to activity), importance of self-care, and compliance with PT / HEP.

Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Moderate

Indications

All patients undergoing arthroplasty.

Rationale

Most studies of educational interventions involved hip and/or knee patients and have demonstrated benefits (Hopman-Rock et al., 2000, Mancuso et al., 2008, Vukomanovic et al., 2008, Butler et al., 1996, Hoorntje et al., 2020, Hanley et al., 2021, Lee et al., 2025, Soeters et al., 2018, Terradas-Monllor et al., 2025, Eschalier et al., 2017, Leal-Blanquet et al., 2013, Wilson et al., 2016). One trial showed modest benefit of training on realistic outcomes (Lee et al., 2025), and another has suggested preoperative setting of goals with a therapist improves post-operative goal-attainment, although the encouragement of crutch use for 4-6 weeks likely delayed recovery (Hoorntje et al., 2020). One trial found a specific audiovisual disc to be unhelpful (Leal-Blanquet et al., 2013), while another found an education program did not change post-op symptoms (Wilson et al., 2016). Lengths of contact have ranged widely, although most studies do not report educational contact time.

One trial has shown preoperative education accelerated time to meet functional outcomes (Soeters et al., 2018), another showed benefits among those prone towards catastrophization (Terradas-Monllor et al., 2025), and improvement in knowledge was shown in a third trial (Eschalier et al., 2017), and another small trial suggested efficacy (Al-Heizan MO,). Retrospective data of patients with optimal outcomes suggest it may also be helpful to discuss post-operative opioid sparing pain control, realistic expectations for improvements in pain and function including RTW, importance of self-care and compliance with PT / HEP (Leon B, 2025). Some programs encourage involvement of family members

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and other care givers. Better post-operative compliance with rehabilitation has been shown in patients who have participated in educational interventions (Wong et al., 1985).

Numerous studies have combined exercises and other interventions with educational interventions. However, nearly all studies reporting length of hospital stay have shown earlier hospital discharge after hip arthroplasty with educational interventions (Wong et al., 1990, Gammon et al., 1996, Gammon et al., 1996, Siggeirsdottir et al., 2005, Pour et al., 2007). Other studies have shown earlier performance of activities such as stair climbing (Gocen et al., 2004) and reductions in pain and anxiety (Giraudet-Le Quintrec et al., 2003, Lloyd A, 2026).

A systematic review concluded there was insufficient evidence to guide an ideal educational program's design, but suggested there is evidence of efficacy of education (Anderson et al., 2022). A Cochrane review concluded that "Although preoperative education is embedded in the consent process, we are unsure if it offers benefits over usual care in terms of reducing anxiety, or in surgical outcomes, such as pain, function and adverse events," although that review is over a decade old (McDonald S, 2014).

Because the evidence suggests efficacy for preoperative education, it is recommended for patients before arthroplasty.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Education OR preoperative education program; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1261 articles in PubMed, 8 in CINAHL, 629 in Cochrane Library, 17,700 in Google Scholar, and 8 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 8 from Google Scholar, and 0 from other sources. Of the 8 articles considered for inclusion, 7 randomized trials and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

PREOPERATIVE EXERCISE

Pre-operative exercise programs have been prescribed to attempt to improve arthroplasty results and reduce complications [1016-1024].

PREOPERATIVE EXERCISE PROGRAM

Recommended

A preoperative exercise program, particularly emphasizing cardiovascular fitness and strengthening, is recommended prior to knee arthroplasty (Gocen et al., 2004, Wang et al., 2002, Rooks et al., 2006).

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Preoperative arthroplasty patients who have muscle weakness and/or debility, particularly sufficient weakness to have impairments such as unsteady gait, difficulty with use of stairs or difficulty with ADLs.

Benefits

Accerated recovery in postop functional measures

Harms

Negligible.

Frequency/Dose/Duration

Most program elements require an initial appointment to teach exercises followed by a home exercise program prescription. Two or three follow-up appointments for adherence and additional exercise instruction may be needed. Patients with severe deficits may require 2 to 3 appointments a week for 4 to 6 weeks in advance of arthroplasty (Rooks et al., 2006). Patients with minimal deficits may benefit from a single appointment to teach programmatic elements for a self-directed program.

Indications for discontinuation

Achievement of program goals, resolution of strength or gait deficits, intolerance or other adverse effects.

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Rationale

In a systematic review and meta-analysis, the majority of the ~60,000 patients recovered most of their function gained over the first postoperative year in the first 3 months (Sayah et al., 2021). Thus, the primary use of prehab is to accelerate that typical recovery trajectory, presumably based on this evidence, among a minority of patients.

The overall literature base is notable for numerous small studies with sparse methods and results (Domínguez-Navarro et al., 2021, Skoffer et al., 2016, Skoffer et al., 2020, An et al., 2021, Casaña et al., 2019, Alghadir et al., 2016, Huber et al., 2015, Brown et al., 2012, Swank et al., 2011, Meyer et al., 2023, Soni et al., 2012, Huang et al., 2012, Kim et al., 2021, Zheng et al., 2022, Calatayud et al., 2017, Jin et al., 2024)(D'Lima et al., 1996, Weidenhielm et al., 1993) that, without a few larger trials, would preclude an evidence-based recommendation. Some trials have suggested benefits, but some have not (Topp et al., 2009, Beaupre et al., 2004). One trial of a multidisciplinary rehab program before surgery showed lack of efficacy among patients who were only 27-34% independent on POD#1 thus apparently among those fairly debilitated preoperatively (Nguyen et al., 2022). One moderate-quality study demonstrated there were benefits from a 6-week pre-operative exercise program that consisted of several elements broadly including cardiovascular, strengthening and flexibility exercises with 30 to 60-minute sessions 3 times a week (Rooks et al., 2006). Another trial reported prehab accelerates functional outcomes (Matassi et al., 2014). The benefits included reduced post-operative complications, earlier discharge and higher probability to be discharged directly to the patient's home. A second moderate-quality study demonstrated benefits of a peri-operative exercise program and also demonstrated benefits lasting 6 months after surgery (Wang et al., 2002). A trial of blood flow restriction exercise found a lack of benefits (Jørgensen et al., 2024). Another moderate-quality study was reported as negative using the author's main outcome of changes in Harris Hip Scores. However, all 5 postoperative milestones (e.g., walking, chair transfer, stair climbing) statistically favored the exercise group (Gocen et al., 2004). Systematic reviews have found better supportive evidence for hip than for knee arthroplasties (Konnyu et al., 2023) (Gill SD, 2013), prehab results in relatively small functional benefits (Moyer et al., 2017, Vervullens et al., 2023, Vasileiadis et al., 2022), shortened hospital length of stays among the elderly (Vasta et al., 2020) although it has also been noted that the overall literature base is relatively sparse (Adebero et al., 2024).

Preoperative rehabilitation has some evidence of efficacy, especially at higher intensities. For select higher-risk and deconditioned patients, it is likely useful as a component of preoperative education and exercise programs. However, most patients without significant functional deficits do not require preoperative programs, based on the current evidence.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Preoperative Exercise; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly;

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systematic, systematic review, retrospective, and prospective studies. We found and reviewed 45 articles in PubMed, 64 in CINAHL, 8 in Cochrane Library, 17,000 in Google Scholar, and 0 from other sources†. We considered for inclusion 14 from PubMed, 7 from CINAHL, 1 from Cochrane Library, 6 from Google Scholar, and 0 from other sources. Of the 28 articles considered for inclusion, 9 randomized trials and 19 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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POSTOPERATIVE REHABILITATION

Exercise, physical therapy, occupational therapy, and rehabilitation have been used preoperatively as well as post-operatively for rehabilitation of arthroplasty patients [1025-1033]. Continuous passive-motion machines have also been used in rehabilitation of arthroplasty patients [1034,1035].

See also the recommendations in the Chronic Pain Guideline for the following:

- Work Conditioning, Work Hardening, Early Intervention Programs, and Back Schools for Chronic Pain
- Interdisciplinary Pain Rehabilitation Programs, Multidisciplinary Rehabilitation Programs, Chronic Pain Management Programs, and Functional Restoration Programs
- Biofeedback

POSTOPERATIVE REHABILITATION FOR KNEE ARTHROPLASTY

Recommended

Postoperative rehabilitation is recommended for patients who underwent knee arthroplasty. There is no clear superiority of one type of program. However, low-quality evidence suggests the most effective approach is app-based or home-based, with both greater and earlier intensity.

Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Moderate

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Indications

Patients who underwent knee arthroplasty.

Benefits

Earlier functional recovery.

Harms

Negligible.

Frequency/Dose/Duration

Treatment may need individualization based on factors including pre-operative conditioning and immediate postoperative results and goals. Treatment is typically initiated at 2 to 3 sessions a week. One trial suggested an educational kneeling intervention had demonstrable long-term benefits (Jenkins et al., 2008). Three trials have suggested benefits of accelerated and/or early rehabilitation (Munin et al., 1998, Reilly et al., 2005, Moffet et al., 2004).

Indications for discontinuation

Achievement of goals, non-compliance with clinic or home-based exercises or intolerance.

Rationale

Over the past few decades, TKA patients have gradually been ambulated earlier and are now generally walked with a walker and demonstrate use of stairs immediately after surgery while in recovery and, if demonstrated independence, then most are discharged on the same day as surgery or at latest, the following day. These major changes likely limit the utility of some of the published literature, especially that which addresses inpatient settings, although those studies too show accelerated physical therapy results in superior outcomes (Henderson et al., 2018); as well, outpatient therapy has been shown to be noninferior (Li et al., 2017), and supervised therapy has not been shown to be superior to unsupervised programs (Bravi et al., 2023). Group exercise has not been shown to be superior to usual care (Fransen et al., 2017). Furthermore, high-intensity progressive rehabilitation has been shown superior to usual care for both functional gain and satisfaction (Jiao et al., 2024). One trial found lack of efficacy of a 15-minute walk beginning on the day of surgery (Zietek et al., 2015), which considering the body of evidence, seems likely to indicate an insufficient dose. A trial of balance training also suggested efficacy (Liao CD, 2015). There are five low-quality trials (Reilly et al., 2005, Moffet et al., 2017, Shim et al., 2023, Paravlic et al., 2019).

Remote/virtual physical therapy has been shown to be noninferior to traditional therapy (Prvu Bettger et al., 2020, Moffet et al., 2015, Eichler et al., 2019)(Bradbury TL, 2024), while one trial reported it also cost 63% less and was associated with 60% fewer hospitalizations over the following year (30 vs. 12, p=0.007) (Prvu Bettger et al., 2020). A home-based program has also been shown to be noninferior to outpatient therapy in two trials

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(Hamilton et al., 2020, Barker et al., 2020). Web-based apps have been show to be either noninferior or superior to traditional home-based rehabilitation (Wang et al., 2021, Zhao et al., 2024).

The pattern of studies above suggests more intensive exercise results in superior outcomes. They also suggest home- or app-based exercises may at least partially supplant traditional physical therapy in rehabilitation of arthroplasty patients.

Accelerated home- and app-based rehabilitation programs have been assessed and appear to be superior to usual care (Munin et al., 1998, Reilly et al., 2005, Moffet et al., 2015, Moffet et al., 1994, Moffet et al., 2017, Hamilton et al., 2020, Barker et al., 2020, Zhao et al., 2024)(Munin et al., 1998, Reilly et al., 2005, Moffet et al., 2004). One trial showed superiority of rehabilitation initiated within 24 hrs to delayed treatment at 48-72 hours (Labraca NS, 2011). There is no demonstrable difference between clinic- and home-based rehabilitation programs or between home and hospital-based care after arthroplasty (Kramer et al., 2003, Shepperd et al., 1998). Exercise and rehabilitation have some evidence of efficacy (especially virtual/remote, apps, and home-based), are not invasive, have low adverse effects, and are moderate to high cost, depending on use of televisits/apps and the numbers of appointments required; thus, they are recommended. Traditional therapy may still play a role in some patients, especially those with major deficits and/or needing greater assistance with the performance of exercise.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: post-operative and rehabilitation and knee arthroplasty; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 24 articles in PubMed, 23 in CINAHL, 14 in Cochrane Library, 17 900 in Google Scholar, and 2 from other sources†. We considered for inclusion 1 from PubMed, 0 from CINAHL, 1 from Cochrane Library, 0 from Google Scholar, and 2 from other sources. Of the 4 articles considered for inclusion, 3 randomized trials and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

CONTINUOUS PASSIVE MOTION AFTER KNEE ARTHROPLASTY

Not Recommended

Continuous passive motion is not recommended for routine use for after knee arthroplasty. It may be useful postoperatively for select patients who are substantially physically inactive.

Strength of evidence Moderately Not Recommended, Evidence (B)
Level of confidence Low

Rationale

Most of the available quality trials concern continuous passive motion (CPM) devices in the immediate postoperative period (Beaupre et al., 2001, Denis et al., 2006, McInnes et al., 1992, Montgomery et al., 1996, Ritter et al., 1989, Chen et al., 2000). This literature base has many older, lower quality trials (Walker et al., 1991, Ververeli et al., 1995, Chiarello et al., 1997, Gotlin et al., 1994, Harms et al., 1991, Johnson et al., 1992, Kumar et al., 1996, Lau et al., 2001, Lotke et al., 1991, May et al., 1999, Pope et al., 1997, Vince et al., 1987, Worland et al., 1998)(Rana et al., 2023). Trials comparing CPM with splinting have suggested efficacy (Johnson, 1990). However, over the past 25 years, patients have gradually been ambulated earlier and are now generally placed on immediate weight bearing status, which appears a likely reason that both of the more recent and higher quality studies have failed to show benefits from use of CPM (Beaupre et al., 2001, Denis et al., 2006)(Gil-González et al., 2022, Joshi et al., 2015) (Harvey LA, 2014). This device is likely preferable to no activity; however, for most patients, ambulation and active exercise appears superior. Thus, CPM is not recommended for most patients, but it may retain some utility for selected, relatively inactive patients in the immediate postoperative period who do not tolerate compressive graduated compressive stockings.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: continuous passive motion AND total knee arthroplasty AND rehabilitation ; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 6 articles in PubMed, 105, 801 in CINAHL, 0 in Cochrane Library, 15 500 in Google Scholar, and 1 from other sources†. We considered for inclusion 1 from PubMed, 1 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 1 from other sources. Of the 3 articles considered for inclusion, 2 randomized trials and 1 systematic reviews met the inclusion criteria.

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Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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RETURN TO ACTIVITY

There are three primary methods to assess appropriate sports or activities for patients after knee arthroplasty: epidemiological studies, biomechanical modeling, and experimental studies. The evidence is somewhat conflicting and no randomized studies exist, so epidemiological studies were primarily used to develop quality guidance for most key questions regarding return to activity [1036,1037,1038]. This review emphasizes higher-quality epidemiological studies.

Most patients under 65 years of age return to work at an average of 7-17 weeks after knee arthroplasty. Factors predicting success include younger age, less physically demanding jobs, and less preoperative absence from work [1039,1040,1041,1042,1043], although one study found no relationship with job physical demands [1044] and another found weak associations [1045]. A pooled return-to-work estimate was 65% at a mean 13 weeks [1040]. By 6 months after knee arthroplasty, 72% of patients younger than 65 years were employed vs. 75% after hip arthroplasty [1046] A population-based Finnish study found 87% of arthroplasty patients returned to work within 1 year at an average 116 days [1042]. Thus, the majority of patients are able to return to work after arthroplasty. Knee pain and stiffness are significant predictors of less successful and later return to work [1047], suggesting potential benefits from targeted rehabilitation. The most difficult task, and thus the greatest potential limitation in return to work/return to activity is kneeling with a majority of patients rating kneeling as either much/extreme difficulty or impossible [1048], which should also beget one of the foci of rehabilitation.

Numerous studies show a substantial proportion of patients successfully returning to sports, including some high-impact activities previously discouraged after arthroplasty. For example, many studies of knee arthroplasty patients now report successful and safe return to downhill skiing [1049], running, hiking, golf, tennis, racquetball, squash, cycling, swimming and basketball [1050,1051,1052,1053,1054,1055][1040]. A pooled estimate of return to sports found the overall rate was 82% with 76% for low-intensity sports and 35% for high intensity sports, with indications that success is somewhat dependent on prior activity levels and fitness

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[1040], while another estimate was an 88% return to sports rate [1056]. Success appears somewhat dependent on preoperative fitness and activity levels.

One concern has been increased wear rates for prosthetic joints subjected to sports or manual labor [1057]. While joint use has been thought to be an important factor, the evidence is primarily derived from biomechanical studies and not quality epidemiological studies with large sample sizes. The annual rate of wear has been measured in a small necropsy study at 0.127 mm, with wear rates reportedly worse with activity [1058]. However, that study which also evaluated multiple factors found body mass index as the most important factor, which creates a conflict between physical activity and body mass index. Most supporting evidence is derived from biomechanical rather than large epidemiological studies, raising questions about whether activity-related wear in biomechanical studies is clinically meaningful for most patients. Another large case series reported worse outcomes with increased body mass index, higher Deyo-Charlson index, female gender, age over 80 years and comorbidities [1059]. Younger patients are presumed to be considerably more active on average than older patients, yet such a cohort of younger active patients reported a 94% 18-year arthroplasty survival rate [1060]. Thus, the importance of activity for joint survival is somewhat unclear.

Patients who undergo unicompartmental knee arthroplasty return to work sooner (73% vs. 48% within 3 months), although the overall long-term RTW rate is comparable to that of patients who undergo total knee arthroplasty [1047,1061]. One report noted 93 to 95% of patients returned to sports [1062,1063]. Others have similarly found more patients with unicondylar arthroplasties return to sports compared with total knee arthroplasty patients [1064], although these studies could be confounded by other factors.

A related issue is lack of use after arthroplasty from fear of use or fear of excessive wear, which could worsen outcomes and incur worse health outcomes associated with inactivity. For example, one descriptive study found few golfers walked the course after arthroplasty and suggested education to increase exercise is needed [1065]. Among the determinants of post-operative activity levels, pre-operative condition is thought to be an important, if not the most important factor.

Operative approaches in relation to return to sports have not been well studied, although evidence suggests minimal differences in return to usual functions (see Arthroplasty above). Minimally invasive approaches have been hypothesized to potentially be better for return to sports activity, particularly in the early phases. No differences by type of operation have been found.

Studies on prosthetic wear rates have been used to imply appropriate work limitations for the post-arthroplasty patient. However, no quality studies have been reported that address the appropriateness of work limitations. Additionally, the avocational studies reviewed above do not provide quality evidence in support of activity limitations. Thus, although reduced return-to-work status has been reported among patients with more physically demanding work, there is not a strong rationale for work restrictions in the post-arthroplasty knee population.

*Almost no RCTs have addressed return to activity other than a number of post-operative rehabilitation studies such as a study of ergometer cycling that found it ineffective in contrast with hip rehabilitation (see Hip and Groin Disorders guideline).

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POSTOPERATIVE VOCATIONAL OR AVOCATIONAL ACTIVITIES

No Recommendation

There is no recommendation for or against specific vocational or avocational pursuits postoperatively.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

Quality evidence does not sufficiently support evidence-based guidance and therefore there is no recommendation for or against specific vocational or avocational activities. However, anecdotal information suggests that there are no limitations in either avocational or vocational activities post-operatively. One trial has suggested preoperative goal-setting with a therapist improves postoperative goal attainment (Hoorntje et al., 2020).

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Post-operative vocational activities, post-operative avocational activities; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 762 articles in PubMed, 0 in CINAHL, 164 in Cochrane Library, 109 in Google Scholar, and 0 from other sources†. We considered for inclusion 1 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trial and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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BEHAVIORAL AND PSYCHOLOGICAL INTERVENTIONS

See the recommendations in the Chronic Pain Guideline for the following:

- Psychological Evaluation for Chronic Pain
- Cognitive Behavioral Therapy for Patients with Chronic Pain

PREVENTION OF VENOUS THROMBOEMBOLIC DISEASE

Venous thromboembolic disease (VTED) is a high-risk complication among post-operative knee and hip arthroplasty patients resulting in morbidity and mortality. This topic is extensively reviewed in the Hip and Groin Disorders guideline. Only the recommendations are reviewed here, and the reader is referred to the Hip and Groin Disorders guideline for further details.

Reported risk factors in these post-operative patients include age, prior history of venous thromboembolic phenomenon, general anesthesia, and obesity. There has been some review of risk of VTED from cement; however, the evidence conflicts [1066,1067]. Treatments have included early ambulation (discussed elsewhere), compression boots or stockings [1068] and other methods [1069], and medications [1070-1078]. There are currently four classes of medications used to prevent VTED: warfarin/ coumadin [1079,1080], low molecular weight heparin [1081-1091], Factor Xa inhibitors [1092], and direct thrombin inhibitors [1093]. While initially believed to be a complication of hospitalization, post-hospital discharge surveillance data suggest high risks of thromboembolism continue well after discharge [1094], with many studies treating patients for 30 days for longer.

COMPRESSION STOCKINGS FOR PREVENTION OF VENOUS THROMBOEMBOLIC DISEASE

Recommended

The use of lower extremity compression devices is recommended for the prevention of venous thromboembolic disease (Kalodiki et al., 1996, Hui et al., 1996).

Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Moderate

Indications

All post-operative major knee surgical patients (e.g., knee fractures, knee arthroplasties, or any other patients thought at increased risk of VTED in the post-operative period), especially those who are not immediately ambulatory.

Benefits

Reduced risk of DVTs.

Harms

Negligible for most patients, although some skin problems may occur particularly with prolonged use.

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Frequency/Dose/Duration

Duration somewhat unclear, but likely at least as long as the patient is nonambulatory and longer use does not add expense. As risk of VTED is high, particularly for these major procedures, threshold for use of 2 weeks or longer should be generally low.

Rationale

Compression devices have been assessed in quality studies and found to strongly prevent DVTs among hospitalized surgical patients (Kaempffe et al., 1991, McKenna et al., 1980, Hui et al., 1996); a Cochrane review reported similar findings (Sachdeva et al., 2018). Adjunctive use to compression stockings plus enoxaparin has been reportedly both successful (Lobastov et al., 2021) and adjunctive use with pharmacologic thromboprophylaxis was not successful (Arabi et al., 2019). Thus, compression devices are recommended particularly for patients who are nonambulatory, when pharmacological thromboprophylaxis is not used, or for patients at very highest risk for potential adjunctive use (Turner et al., 2024, Lobastov et al., 2021).

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Compression Stockings and Deep Vein Thrombosis; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 0 in CINAHL, 0 in Cochrane Library, 1 370 in Google Scholar, and 2 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 2 from other sources. Of the 4 articles considered for inclusion, 1 randomized trial and 3 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of

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100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

LOW-MOLECULAR WEIGHT HEPARIN FOR PREVENTION OF VENOUS THROMBOEMBOLIC DISEASE

Recommended

Low-molecular weight heparin is strongly recommended for prevention of venous thromboembolic disease.

Strength of evidence Strongly Recommended, Evidence (A)
Level of confidence High

Indications

Postoperative hip/knee arthroplasty, knee fracture, and other major hip/knee/lower extremity surgery patients, particularly those with history of prior thromboemboli and either prolonged inactivity or prolonged reduced or sedentary activity levels (Heparin Arthroplasty Group, 1994, Kalodiki et al., 1996, Planes et al., 1996, Planes et al., 1996, Comp et al., 2001, Arnesen et al., 2003, Bergqvist et al., 1996, Dahl et al., 1997, Heit et al., 2000, Hoek et al., 1992, Jorgensen et al., 1992, Lassen et al., 1998, Turpie et al., 1986). There is some evidence LMWH is generally preferable to warfarin for VTED prophylaxis. Patients with prior reactions to LMWH should generally receive other treatments first.

Frequency/Dose/Duration

Subcutaneous injections of enoxaparin (Lovenox) 4,000 IU or 40mg SC QD (Kalodiki et al., 1996, Planes et al., 1996, Planes et al., 1996, Comp et al., 2001, Bergqvist et al., 1996, Planes et al., 1998, Bara et al., 1999, Eriksson et al., 2006, Eriksson et al., 2006, Eriksson et al., 2007, Spiro et al., 1994) for variable durations ranging from 5 to 9 post-operative days (Eriksson et al., 2006, Eriksson et al., 2006, Eriksson et al., 2007) to 8 to 14 days (Bara et al., 1999) to 10 to 14 days (Planes et al., 1998), 21 days (Planes et al., 1996, Planes et al., 1996), 30 days (Bergqvist et al., 1996), to 12 weeks (Comp et al., 2001). There is no consensus on duration of treatment, and individualization based on activity level appears indicated. One trial showed equivalence between enoxaparin and ASA when added to calf compressive devices after total knee arthroplasty (Westrich et al., 2006).

Duration is unclear. Available quality studies utilized treatment courses ranging from 4 days (Jorgensen et al., 1992) to 12 weeks (Comp et al., 2001). A plurality of studies utilized a course of 30 to 35 days (Arnesen et al., 2003, Bergqvist et al., 1996, Dahl et al., 1997, Lassen et al., 1998). There is some evidence that treatment may be required beyond hospitalization; there is evidence of deep venous thromboses many months later (reviewed above). One quality trial suggested no benefits from extending 4 to 10 days treatment out to 12 weeks (Heit et al., 2000). In the absence of substantive quality data comparing various durations of treatment, it is suggested that approximately 30 days of treatment after surgery may be required for average patients (a single trial suggested 30 to 42 days after arthroplasty) (Eikelboom et al., 2001). Patients with prior histories of venous thrombi,

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prolonged inactivity, delayed recovery or recurrences of thromboses, or family histories of venous thrombi likely require longer courses. Those with major risk of bleeding may warrant individualized shorter courses. Patients who regain activity rapidly may be appropriate candidates for shorter courses of treatment.

There is no consensus on duration of treatment, and individualization based on activity level appears indicated.

Indications for discontinuation

Completion of course of treatment, attainment of normal mobility status, development of major complication (e.g., major bleeding) or other adverse effect.

Rationale

There are many trials of low-molecular weight heparin. The quality studies that compared treatment with placebo or no treatment have mostly reported preventive benefits (Shang et al., 2024, Bern et al., 2015) with one large study suggesting a lack of efficacy (van Adrichem et al., 2017). Superiority to compression stockings has been shown (Camporese et al., 2008). Equivalency with ASA has also been shown in some trials (Haac et al., 2020, Anderson et al., 2013), although one meta-analysis suggested LMWH is superior to ASA (Salman et al., 2025). These have shown reductions in deep venous thrombosis of approximately 33% compared with warfarin and result in lower incidence of heparin-associated thrombocytopenia. While mildly invasive and with some adverse effects, LMWHs are effective in reducing risk of VTED and thus are strongly recommended especially among those patients who are not immediately ambulatory after surgery.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Heparin, Low-Molecular-Weight; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 290 articles in PubMed, 446 in CINAHL, 88 in Cochrane Library, 4980 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 7 from other sources. Of the 7 articles considered for inclusion, 5 randomized trials and 2 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full

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evidence base used in this guideline includes all relevant studies identified without date constraints.

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FACTOR XA INHIBITORS FOR PREVENTION OF VENOUS THROMBOEMBOLIC DISEASE

Recommended

Factor Xa inhibitors are strongly recommended for the prevention of venous thromboembolic disease.

Strength of evidence Strongly Recommended, Evidence (A)
Level of confidence High

Indications

Post-operative arthroplasty, knee fracture, or other major knee surgery patients, particularly those with prior thromboemboli and either prolonged inactivity or prolonged reduced or sedentary activity levels (Eriksson et al., 1997, Agnelli et al., 2007, Eriksson et al., 2003, Eriksson et al., 2001, Thorpe et al., 1994). Patients with prior reactions should generally receive other treatments first. Patients with renal failure or renal insufficiency should generally receive a different medication due to renal excretion of this compound.

Frequency/Dose/Duration

Common Factor Xa inhibitor medications are: Fondaparinux (Arixtra) 2.5mg SC QD, Rivaroxaban (Xarelto), Apixaban (Eliquis), and Edoxaban (Savaysa). Dose and frequency depend on indications.

Duration unclear. Literature suggests duration be individualized based on factors such as prolonged inactivity, delayed recovery or thrombotic recurrences, prior history, and risks of bleeding.

Indications for discontinuation

Completion of course of treatment, development of major complication (e.g., major bleeding) or other adverse effect.

Rationale

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There are a few studies of Factor Xa inhibitors, with quality studies having shown Fondaparinux and rivaroxaban superiority to placebo (Van Herck P, 2010, Eriksson et al., 2003, Camporese et al., 2016). Additionally, these agents have been shown to be superior to enoxaparin in two quality studies (Manheimer E, 2006, Tucker et al., 2003, Eriksson et al., 2001, Eriksson et al., 1997), although equivalent in another (Pollard et al., 2008, Agnelli et al., 2007). Equivalence of rivaroxaban with ASA has been shown among hip and knee arthroplasty patients (Anderson et al., 2018). Major bleeding appears more common with Fondparinux than enoxaparin (Licciardone et al., 2004, Turpie AG, 2002). While mildly invasive and with some adverse effects, these medications are effective in reducing risk of VTED and thus are strongly recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Factor Xa Inhibitors OR Rivaroxaban OR Apixaban OR Edoxaban OR Betrixaban; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 45 articles in PubMed, 413,779 in CINAHL, 13 in Cochrane Library, 2,180 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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WARFARIN AND HEPARIN FOR PREVENTION OF VENOUS THROMBOEMBOLIC DISEASE

Recommended

Warfarin and heparin are moderately recommended for prevention of venous thromboembolic disease.

Strength of evidence Moderately Recommended, Evidence (B)

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Level of confidence Moderate

Indications

Post-operative arthroplasty, knee fracture, other major knee surgery and among those with prior thromboemboli (Beisaw et al., 1988, Powers et al., 1989). Patients with adverse reactions to warfarin may be maintained on heparin throughout the treatment course. Patients with reactions to heparin, but at increased risk of thrombosis may be started on the other agents and switched to warfarin.

Frequency/Dose/Duration

Subcutaneous injections of Heparin, which can be titrated to the activated partial thromboplastin time (aPTT). Warfarin dose titrated to International Normalized Ratio (INR). Magnitude of anticoagulation is recommended to be individualized, and include risks of thrombi versus risks of bleeding and it is notable that the quality studies utilized a range of INRs.

Duration unclear. Literature suggests duration be individualized based on factors such as prolonged inactivity, delayed recovery or thrombotic recurrences, prior history, and risks of bleeding.

Indications for discontinuation

Completion of course of treatment, development of major complication (e.g., major bleeding) or other adverse effect.

Rationale

There is some quality evidence that heparin is effective compared with placebo (Stakes et al., 2006, Beisaw NE, 1988). One trial reported equivalency of warfarin to fondaparinux, although it was potentially underpowered (Bern et al., 2015). However, a moderate quality study found dextran superior to subcutaneous heparin administration (Bulow et al., 1994, Bergqvist D, 1979). Heparin may still be an option in select patients who have contraindications for using other more effective medications for VTED prevention. While mildly invasive and with some adverse effects, these medications are effective in reducing risk of VTED and thus are recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Warfarin, Heparin; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1,728 articles in PubMed, 317,925 in CINAHL, 26 in Cochrane Library, 18,900 in

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Google Scholar, and 3 from other sources†. We considered for inclusion 7 from PubMed, 1 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 1 from other sources. Of the 9 articles considered for inclusion, 4 randomized trials and 5 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ASPIRIN FOR PREVENTION OF VENOUS THROMBOEMBOLIC DISEASE

Recommended

Aspirin is recommended for the prevention of deep venous thrombosis.

Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Moderate

Indications

Post-operative hip/knee arthroplasty, knee fracture, and other major lower extremity surgery patients.

Benefits

Reduced risks of DVT, PE and also likely to be associated with reduced myocardial infarctions.

Harms

ASA has been found to have comparable adverse effects to other anticoagulants for thromboprophylaxis (Matharu et al., 2020, Cheok et al., 2024).

Frequency/Dose/Duration

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Most studies have used ASA 81 mg/day.

Indications for discontinuation

Completion of course of treatment, development of major complication (e.g., major bleeding) or other adverse effect.

Rationale

Quality trials have mostly suggested that aspirin is equivalent to LMWHs for the prevention of DVTs (Haac et al., 2020, Anderson et al., 2013, Anderson et al., 2018, Westrich et al., 2006) (Yi, 2014). Because aspirin has evidence of efficacy and is low cost, it is recommended for the prevention of venous thromboembolic disease.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Aspirin; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 355 articles in PubMed, 236 in CINAHL, 71 in Cochrane Library, 17,500 in Google Scholar, and 2 from other sources†. We considered for inclusion 8 from PubMed, 4 from CINAHL, 0 from Cochrane Library, 3 from Google Scholar, and 0 from other sources. Of the 15 articles considered for inclusion, 6 randomized trials and 9 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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FACTOR XIA INHIBITORS FOR DVT PREVENTION

Recommended

Factor XIa inhibitors are recommended for the prevention of DVTs.

Strength of evidence Strongly Recommended, Evidence (A)
Level of confidence High

Indications

Post-operative arthroplasty, knee fracture, or other major knee/hip/lower extremity surgery patients, particularly those with prolonged inactivity or prolonged reduced or sedentary activity levels (Eriksson et al., 1997, Agnelli et al., 2007, Eriksson et al., 2003, Thorpe et al., 1994). Patients with prior reactions should generally receive other treatments first.

Indications for discontinuation

Cessation of increased risk of thromboemboli, such as regaining normal function, also allergic reactions or intolerance.

Rationale

There are a studies of Factor XIa inhibitors, with quality studies having shown efficacy of abelacimab (Verhamme et al., 2021), Milvexian (Weitz et al., 2021) and osocimab for the prevention of DVTs typically be using comparisons of known efficacy such as enoxaparin (Weitz et al., 2020). While mildly invasive and with some adverse effects, these medications are effective in reducing risk of VTED and thus are strongly recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: venous thromboembolic disease prevention OR anticoagulants; Osteoarthritis, osteoarthrosis, acute knee pain, subacute knee pain, chronic knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 23 in CINAHL, 3 in Cochrane Library, 18800 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 3 from Google Scholar, and 0 from other sources. Of the 3 articles considered for inclusion, 3 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior

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ILIOTIBIAL (IT) BAND SYNDROME

Iliotibial band syndrome is believed to occur in susceptible individuals with exposure to forceful, repeated movement of the iliotibial band over the lateral femoral condyle with resultant friction [87,88,90,91,92,93,94]. This disorder has been reported mostly in discrete, physically active populations, including runners, military recruits, weight lifters, bicyclers, and downhill skiers [90,92,94-110]. Quality epidemiological studies are absent, but purported risk factors include increased activity, genu varus, leg length discrepancies, running surface and shoe wear [88,114,115]. The results are thought to include tendinopathy-like changes involving the iliotibial tract with accompanying inflammation of the lateral synovial recess [88,90,92,116-122].

The diagnosis is mostly clinical, with presenting symptoms of lateral thigh and/or hip pain. MRI has been used for evaluation of IT band syndrome [116,117,1095]. Treatment has largely been empiric, as quality evidence has been notably sparse [391]. Conservative treatment has been thought to be successful [119,120,1096]. Treatments have predominantly included: reducing the exposure factor(s) and rest [89,96,108,119,123,1096,1097,1098], NSAIDs, gradual return to activity, ice [88,107,108,109,123], massage [107,123,1099], physical therapy, stretching of the IT band [88,100,108,1100], and local injections.

TREATMENT RECOMMENDATIONS

ACTIVITY MODIFICATION AND EXERCISE

Recovery is often successful when a training program is started at a lower demand level and the intensity and duration slowly progress.

STRETCHING

STRETCHING EXERCISES FOR ILIOTIBIAL BAND SYNDROME

Recommended

Stretching exercises are recommended for iliotibial band syndrome.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

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There are no quality studies of stretching for IT band syndrome (van der Worp et al., 2012, Sanchez-Alvarado et al., 2024, Balachandar et al., 2019, Miccio et al., 2021). However, stretching exercises are believed to be potentially effective for improving and resolving IT band syndrome; thus, they are recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Muscle Stretching Exercises; Iliotibial Band Syndrome, ITB friction syndrome, IBB syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1 articles in PubMed, 1 in CINAHL, 2 in Cochrane Library, 18,700 in Google Scholar, and 2 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 5 from Google Scholar, and 2 from other sources. Of the 7 articles considered for inclusion, 3 randomized trials and 4 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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STRENGTH TRAINING

STRENGTHENING EXERCISES FOR ILIOTIBIAL BAND SYNDROME

Recommended

Strengthening exercises are recommended for treatment of iliotibial band syndrome.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Patients with IT band syndrome.

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Benefits

Reduction in pain and improved function

Harms

Negligible

Frequency/Dose/Duration

A set of approximately 6-8 appointments. Additional sets of appointments should be based on progressive gains in function along with expectations that these gains have not plateaued.

Indications for discontinuation

Completion of a course, sufficient resolution of the disorder, non-compliance.

Rationale

There are no quality studies (van der Worp et al., 2012, Sanchez-Alvarado et al., 2024, Balachandar et al., 2019, Miccio et al., 2021). However, strengthening exercises are believed to be important for improving and resolving IT band syndrome; thus, they are recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Muscle Stretching Exercises; Iliotibial Band Syndrome, ITB friction syndrome, IBB syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in CINAHL, 0 in Cochrane Library, 20,200 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ALLIED HEALTH INTERVENTIONS

TAPING

KINESIOTAPING FOR ILIOTIBIAL BAND SYNDROME

No Recommendation

There is no recommendation for or against kinesiotaping for iliotibial band syndrome.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

There are no quality studies of kinesiotaping for iliotibial band syndrome and thus, there is no recommendation.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Athletic Tape, kinesio tape, kinesio taping, kinesiotaping, kinesiology taping, elastic therapeutic tape; Iliotibial Band Syndrome, ITB friction syndrome, IBB syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in CINAHL, 0 in Cochrane Library, 7,400 in Google Scholar, and 0 from other sources†. We considered for inclusion o from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trial and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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MANUAL THERAPY

MANUAL THERAPY AND MOBILIZATION FOR IIIOTIBIAL BAND SYNDROME

No Recommendation

There is no recommendation for or against manual therapy and mobilization for treatment of iliotibial band syndrome.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

There is no quality evidence, although there are low-quality studies that need replication in sizable well-designed studies (Maghroori, 2021, Weckström et al., 2016, Zemadanis et al., 2017). Thus, there is no recommendation for or against manual therapy and mobilization for the treatment of IT band syndrome.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Musculoskeletal Manipulations, manual therapy, mobilization) ; Iliotibial Band Syndrome, ITB friction syndrome, IBB syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 11 articles in PubMed, 4 in CINAHL, 2 in Cochrane Library, 10,100 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 3 from Google Scholar, and 0 from other sources. Of the 3 articles considered for inclusion, 1 randomized trial and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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TRANSVERSE FRICTION MASSAGE FOR ILIOTIBIAL BAND SYNDROME

No Recommendation

There is no recommendation for or against the use of transverse friction massage for the treatment of iliotibial band syndrome.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

There is one small trial assessing additive benefit of transverse friction massage in addition to stretching, ice and ultrasound (Schwellnus et al., 1992). It failed to show improvement, although it may have been underpowered. Thus, there is no recommendation for or against the use of transverse friction massage for treatment of iliotibial band syndrome.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: transverse friction massage; Iliotibial Band Syndrome, ITB friction syndrome, IBB syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 2 in CINAHL, 1 in Cochrane Library, 9,200 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we

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review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

SHOCKWAVE THERAPY

EXTRACORPOREAL SHOCKWAVE THERAPY (ESWT) FOR ILIOTIBIAL BAND SYNDROME

Not Recommended

Shockwave therapy is not recommended for treatment of iliotibial band syndrome.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

There is no quality evidence for ESWT (Rasekhi et al., 2025, Weckström et al., 2016, Maghroori, 2021). Because it is cumulatively moderate to high cost, it is not recommended for treatment of IT band syndrome.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: shockwave therapy, ESWT; Iliotibial Band Syndrome, ITB friction syndrome, IBB syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in CINAHL, 0 in Cochrane Library, 2510 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 12 from Google Scholar, and 0 from other sources. Of the 12 articles considered for inclusion, 2 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date

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100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

INJECTION THERAPIES

Glucocorticoid injections have been used for treatment of IT band syndrome [1101].

GLUCOCORTICOSTEROID INJECTIONS FOR ILIOTIBIAL BAND SYNDROME

Sometimes Recommended

Glucocorticosteroid injections are recommended for the treatment of iliotibial band syndrome in a subset of patients with insufficient results from other treatments.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Iliotibial band syndrome patients with insufficient results from activity modification, relative rest, NSAIDs, and local applications of ice or heat.

Frequency/Dose/Duration

One quality trial used methylprednisolone acetate 40mg mixed with 1% lidocaine, injected between the IT band and lateral femoral condyle (Gunter et al., 2004).

Indications for discontinuation

A second glucocorticosteroid injection is not recommended if the first has resulted in significant reduction or resolution of symptoms. In patients who respond with several weeks of pharmacologically appropriate, temporary, partial relief of pain, but then have worsening pain and function and are not (yet) interested in surgical intervention, a repeat steroid injection is an option, often with a modestly higher dose. If there has been no response to a first injection, the only reason to attempt a second injection is if the interventionalist believes the medication was not well placed, a second injection may be indicated. There is unlikely to be benefit with greater than about 3 injections.

Rationale

There is one small placebo-controlled trial that suggested benefits of injection with glucocorticoid compared with placebo anesthetic for treatment of iliotibial band syndrome (Gunter et al., 2004). Although the trial was small, this is the best evidence available and thus is relied upon for a recommendation. These injections are mildly invasive, have adverse effects, are moderately costly, and appear effective and are therefore recommended.

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Glucocorticosteroid Injections; Iliotibial Band Syndrome, ITB friction syndrome, IBB syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in CINAHL, 0 in Cochrane Library, 2100 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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SURGICAL CONSIDERATIONS

Surgical procedures have been used for treatment of iliotibial band syndrome, which have included x-lengthening [108,1097].

SURGERY FOR ILIOTIBIAL BAND SYNDROME

No Recommendation

There is no recommendation for or against surgery for treatment of iliotibial band syndrome.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Indications

Iliotibial band syndrome patients with insufficient results from activity modification, relative rest, NSAIDs, local applications of ice or heat, and 2 glucocorticoid injections.

Rationale

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There are no quality trials comparing surgery with sham surgery for treatment of iliotibial band syndrome (Inoue et al., 2018, Villanueva et al., 2021). There also are no quality trials comparing surgery with a non-interventional control group. There also are no quality comparative trials for different operative approaches. Therefore, surgery would be a last resort for the small minority of patients with unsatisfactory results from other treatments that generally include at least 2 glucocorticoid injections. Surgery is invasive, has adverse effects, and is highly costly. Therefore, there is no recommendation for or against its use in this small group of patients as data are insufficient and inconclusive.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Operative surgical procedures, surgery; Iliotibial Band Syndrome, ITB friction syndrome, IBB syndrome; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in CINAHL, 0 in Cochrane Library, 1,110 in Google Scholar, and 1 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 1 from other sources. Of the 3 articles considered for inclusion, 2 randomized trials and 1 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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QUADRICEPS, GASTROCNEMIUS, SOLEUS, AND HAMSTRING STRAINS

OVERVIEW

Quadriceps, gastrocnemius, hamstring, and soleus strains are thought to be true muscular strains (i.e., disrupted myotendinous junctions). These problems are usually precipitated by a high-force maneuver, including sports injuries in sprinting, football, or soccer [333,334,335], with near maximum voluntary contraction capabilities. They also result from explosive forces, quick responses, and reaction sports. Prior injury is likely the greatest predictor of future risk. Patients have pain exacerbated by use, stiffness, and weakness.

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TREATMENT RECOMMENDATIONS

ACTIVITY MODIFICATION AND EXERCISE

WORK LIMITATIONS FOR SELECT CASES OF QUADRICEPS, GASTROCNEMIUS, OR SOLEUS STRAINS

Sometimes Recommended

Work limitations are recommended for those with quadriceps, gastrocnemius, or soleus strains performing high physical demand tasks or those who have no ability to avoid repeating physically demanding job tasks thought to have resulted in the condition.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Work limitations for muscle strains may be necessary depending on the severity of the condition and the required job demands, and thus are recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Work limitations; Quadriceps strains, gastrocnemius strains, Soleus strains, adductor strains, knee strains; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 8 articles in PubMed, 0 in CINAHL, 19 in Cochrane Library, 15,600 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

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PROGRESSIVE AGILITY, TRUNK STABILIZATION, AND ICING (PATS) FOR QUADRICEPS, GASTROCNEMIUS, OR SOLEUS STRAINS

Recommended

PATS is recommended for quadriceps, gastrocnemius, or soleus strains.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Frequency/Dose/Duration

See Exercise section for exercise dose, frequency, discontinuation information.

Rationale

There is one small study of treatment options, however, it only addressed exercise (Sherry et al., 2004); thus nearly all treatment recommendations are empiric (Engebretsen et al., 2008, Hartig et al., 1999). A course of rehabilitation therapy is recommended for those with persisting pain, although long term compliance is a noted problem (Engebretsen et al., 2008). A small trial suggests stretching and isolated progressive resistance training are not successful compared with progressive agility, trunk stabilization and icing (PATS) (Sherry et al., 2004); thus PATS is recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Progressive agility trunk stabilization, PATS; Quadriceps strains | gastrocnemius strains | Soleus Strains; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in CINAHL, 1 in Cochrane Library, 325 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 1 articles considered for inclusion, 1 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

KINESIOTAPING FOR KNEE STRAINS

No Recommendation

There is no recommendation for or against kinesiotaping for knee strains.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

There is no quality evidence of efficacy of kinesiotaping for treatment of knee strains and thus there is no recommendation.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Athletic tape, kinesiotaping, kinesio taping; Quadriceps strains | gastrocnemius strains | Soleus Strains; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 6 articles in PubMed, 1 in CINAHL, 0 in Cochrane Library, 4,650 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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THERAPY FOR TREATMENT OF HAMSTRING OR HIP FLEXOR STRAINS

Recommended

Therapy is recommended for treatment of hamstring or hip flexor strains.

Strength of evidence Recommended, Evidence (C)
Level of confidence Moderate

Indications

Most patients may benefit from a course of therapy, but particularly those with strength deficits and/or significant functional impairments.

Benefits

Improve rate of recovery and address functional deficits. One specific type of treatment is PATS (progressive agility, trunk stability and icing) (Sherry et al., 2004).

Harms

Negligible.

Frequency/Dose/Duration

Generally, 1-2 appointments/week, with sets of 6-8 appointments ordered. Another set of appointments is a consideration if there is lack of complete objective recovery or failure to reach an acceptable plateau. Another set of 6-8 appointments would rarely be indicated if there was ongoing objective evidence of improvement after 12-16 appointments.

Indications for discontinuation

Full recovery, completion of a course of therapy and reaching a plateau in healing, noncompliance.

Rationale

There are a few quality studies of exercise (Sherry et al., 2004). Eccentric exercises were reportedly effective in another trial (Petersen J, 2011). Another trial emphasized an individualized program for football players (Mendiguchia J, 2017). Exercise has low adverse effects, is generally low to moderate cost depending on the numbers of appointments, is able to address functional deficits, and is thus recommended. The quality of the available data does not allow for a clear preference of one exercise regimen over another.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Therapy;

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Quadriceps strains | gastrocnemius strains | Soleus Strains; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 266 articles in PubMed, 1 in CINAHL, 9 in Cochrane Library, 17500 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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SURGICAL CONSIDERATIONS

SURGICAL REPAIR OF HAMSTRING OR HIP FLEXOR STRAINS

Recommended

Surgical repair is recommended for treatment of large or complete hamstring, hip flexor, gastrocnemius, soleum, or knee strains.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence High

Indications

Large or complete tears of the hamstrings (i.e., 3 tendon tears and/or 2 tendon tears with more than 2-cm retraction), hip flexor or knee strains with functional deficits felt amenable to surgical treatment. Generally, large or complete tears of these major muscles require surgical repair to facilitate recovery. Regarding proximal hamstring tears of two tendons with less than 2-cm retraction, nonoperative treatment is recommended.

Benefits

Improved functional recovery and reduced pain.

Harms

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Lack of resolution, infection, nerve injury, CRPS.

Rationale

A randomized trial of nonoperative vs. surgical repair for avulsions of 2-3 proximal hamstring tendons less than 4 weeks old in moderately to highly active individuals found comparable results at 1-2 years (Pihl et al., 2024), suggesting that surgical repair is not required. Hamstring tears, gastroc-soleus, hip flexor and knee/calf tears that are large or complete have generally been treated with surgical repair, although there are few quality studies to ascertain efficacy. Surgical repair has adverse effects and is costly, but as these muscles are important for physical function, surgical repair is recommended for those with large tears.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: surgery OR surgical treatment, quadriceps strains, gastrocnemius strains, soleus Strains, controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 25 articles in PubMed, 15 in CINAHL, 5 in Cochrane Library, 14,100 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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KNEE SPRAINS (INCLUDING MEDIAL AND LATERAL COLLATERAL LIGAMENTS; ANTERIOR AND POSTERIOR CRUCIATE LIGAMENTS)

OVERVIEW

Knee sprains are partial or complete disruptions of ligaments [373,1102,1103]. Thus, these injuries are usually a result of high force events, particularly including sporting injuries, slips, trips, falls, motor vehicle accidents and work injuries [373,1102,1104,1105]. The 4 major ligaments of the knee are all susceptible to knee sprains [373,1102]. These are the medial and lateral collateral ligaments, along with the anterior and posterior cruciate ligaments. Sprains are typically graded from I to III ranging from an intact ligament without laxity but with fiber disruption (I) to complete disruption (III) [373,1102,1103]. Low grade sprains are considered to have excellent prognoses [1102,1106,1107,1108]. Grade III sprains are more susceptible to concomitant injuries such as the ACL and menisci [1102]. A careful history will usually result in a presumptive diagnosis that is confirmed on physical examination (see History and Physical Examination sections). Patients have pain exacerbated by use and ligament stretching. The examination findings are focal tenderness over the collateral ligament and pain augmentation with ligamentous stressing for collateral ligament sprains. Examination findings may be normal for Grade I cruciate ligament sprains or include laxity with complete disruptions. Some cases involve complete ruptures and may require surgical repair (see ACL section). Combined ruptures (e.g., MCL plus ACL) are beyond the scope of this guideline as there are few quality studies to define treatment options and both operative and non-operative care has been attempted with successes.

TREATMENT RECOMMENDATIONS

ACTIVITY MODIFICATION AND EXERCISE

WORK LIMITATIONS FOR SELECT KNEE SPRAINS

Sometimes Recommended

Work limitations are recommended for those with knee sprains performing high physical demand tasks or those who have no ability to avoid repeating physically demanding job tasks thought to have resulted in the condition.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Work limitations may be necessary depending on the severity of the condition and the required job demands (Abasolo et al., 2007). Those performing high physical demand tasks or those who have no ability to avoid repeating physically demanding job tasks thought to have resulted in the condition are recommended to have work limitations.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Work limitations;

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Knee strain, lateral ligament strain, collateral ligament strain, anterior cruciate ligament strain, posterior cruciate ligament strain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 7 articles in PubMed, 0 in CINAHL, 41 in Cochrane Library, 33,300 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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INJECTION THERAPIES

PLATELET-RICH PLASMA (PRP) INJECTIONS FOR KNEE SPRAINS

Not Recommended

Platelet-rich plasma (PRP) injections are not recommended for treatment of knee sprains.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

There are only a few small, low-quality trials of PRP for knee sprains. Thus, these injections are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Work limitations; Knee strain, lateral ligament strain, collateral ligament strain, anterior cruciate ligament strain, posterior cruciate ligament strain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and

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prospective studies. We found and reviewed 4 articles in PubMed, 0 in CINAHL, 2 in Cochrane Library, 2880 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 0 from other sources. Of the 2 articles considered for inclusion, 2 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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SURGICAL CONSIDERATIONS

SURGERY FOR GRADE III LATERAL COLLATERAL LIGAMENT (LCL) TEARS

Sometimes Recommended

Surgery is recommended in isolated Grade III LCL tears, recognizing that they are rare.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Surgery is recommended for isolated Grade III LCL tears, recognizing that they are rare. Surgery for isolated Grade III MCL tears is usually not necessary because of the documented excellent healing potential of this ligament with closed (i.e., non-operative) treatment. Surgery is only recommended in those rare select cases of failure of non-operative management.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Work limitations; Knee strain, lateral ligament strain, collateral ligament strain, anterior cruciate ligament strain, posterior cruciate ligament strain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*,

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randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 252 articles in PubMed, 3 in CINAHL, 97 in Cochrane Library, 16800 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 1 articles considered for inclusion, 1 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ANTERIOR AND POSTERIOR CRUCIATE LIGAMENT TEARS

OVERVIEW

This section addresses complete disruptions of the cruciate ligaments. These injuries are most commonly experienced in athletics, as well as acute discrete, forceful traumatic events [(293-313)]. The history and physical examination findings have been previously discussed (see History and Physical Examination and Knee Sprain sections). There are concerns regarding subsequent development of osteoarthrosis, and a positive pivot shift after surgical repair has been reported to predict osteoarthrosis [(1109)].

The anterior cruciate ligament (ACL) is considered the most important stabilizing knee ligament. Thus, this section will primarily address ACL tears. Posterior cruciate ligament tears are uncommon, and rarely require surgery in non-professional athletes. PCL ligament tears are thought to be best rehabilitated with progressive exercises which are recommended (see ACL exercise section above).

Whereas ACL tears were once universally thought to require surgical repair, there is now quality evidence of successful nonoperative rehabilitation in well selected patients (see below). This has somewhat increased the complexity of patient management. For many interventions, there is not quality evidence, and either inference from treatment of other body parts, consensus, and/or expert opinion guide treatments.

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TREATMENT RECOMMENDATIONS

ACTIVITY MODIFICATION AND EXERCISE

WORK LIMITATIONS FOR SELECT CASES OF ACL TEARS

Recommended

Work limitations for ACL tears are usually necessary, especially in the acute phase, although required job demands need to be considered.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

There are no quality trials specifically addressing patients with ACL and PCL tears. Severe cases may be unable to perform any work for at least a few days. Work limitations are usually necessary, especially in the acute phase, although required job demands must be incorporated. Patients frequently have feelings of instability that may require work limitations. Those performing high physical demand tasks or those who cannot avoid repeating physically demanding job tasks similar to those that resulted in the condition are especially recommended to have work limitations. In other cases, particularly where the worker has the ability to modulate work tasks, there is no recommendation for or against work limitations.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Work limitations; posterior cruciate ligament tears, anterior cruciate ligament injuries, posterior cruciate ligament injuries, ACL, Anterior Cruciate ligament; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 113 articles in PubMed, 0 in CINAHL, 7 in Cochrane Library, 16700 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 1 articles considered for inclusion, 0 randomized trials and 1 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

DEVICES

Rest, splints, ice and heat have been utilized for treatment of ACL injuries [294,296,297,298,305,1110,1111]. Functional bracing has been used to prevent and treat ACL injuries; they have also been used post-operatively as part of the rehabilitation program [293,299,300]. There are no quality studies of treatment options aside from exercise, rehabilitation, braces and surgical treatment.

Knee bracing is commonly performed for ACL tears [293-313,685,686,1110,1112,1113]. Most often, hinged braces are used, although there are different models in use.

POSTOPERATIVE BRACING FOR ANTERIOR CRUCIATE LIGAMENT INJURIES

Not Recommended

Postoperative bracing is not recommended for treatment of ACL injuries.

Strength of evidence Moderately Not Recommended, Evidence (B)
Level of confidence Moderate

Rationale

There have been biomechanical and theoretical re-injury prevention reasons for use of post-operative bracing after ACL reconstruction. However currently, there are many RCTs that evaluate the use of braces to treat and rehabilitate postoperative and nonoperative patients with ACL tears. All quality trials suggest lack of efficacy and some report data with trends towards better outcomes in the non-bracing groups (Schoepp et al., 2023, Gunadham et al., 2024, Hiemstra et al., 2009, Mikkelsen et al., 2003, Birmingham et al., 2008, Moller et al., 2001, Brandsson et al., 2001). There are low-quality trials (Mayr et al., 2014). As quality trials consistently suggest lack of efficacy and trends towards worse outcomes with postoperative bracing, postoperative bracing is not recommended.

Use of braces in these patients must balance theoretical stabilization against disuse and delayed recovery. If braces are prescribed it is suggested patients be monitored for progress and generally be engaged in an active exercise program.

Bracing for prevention of knee injuries in American football linemen is a different topic and for which there is some evidence of efficacy (Sitler et al., 1990).

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: post operative braces, postoperative knee braces; posterior cruciate ligament tears, anterior cruciate ligament injuries, posterior cruciate ligament injuries, ACL, Anterior Cruciate ligament; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 60 articles in PubMed, 0 in CINAHL, 16 in Cochrane Library, 16900 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

NONOPERATIVE BRACING FOR ANTERIOR CRUCIATE LIGAMENT INJURIES

No Recommendation

There is no recommendation for or against bracing for nonoperative ACL injuries.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

There are no quality trials of the use of braces for ACL injuries. Braces have been used postoperatively and found to be unhelpful (see separate recommendation). Thus, there is no recommendation for or against bracing for non-operative management of ACL injuries.

Use of braces in these patients must balance theoretical stabilization against disuse and delayed progression. If braces are prescribed it is suggested patients be monitored for progress and generally be engaged in an active exercise program.

Evidence

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A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Braces, knee braces; posterior cruciate ligament tears, anterior cruciate ligament injuries, posterior cruciate ligament injuries, ACL, Anterior Cruciate ligament; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 41 articles in PubMed, 0 in CINAHL, 15 in Cochrane Library, 16800 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 9 from Google Scholar, and 9 from other sources. Of the 9 articles considered for inclusion, 3 randomized trials and 6 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

INJECTION THERAPIES

PLATELET-RICH PLASMA (PRP) INJECTIONS FOR ACL TEARS

Not Recommended

Platelet-rich plasma (PRP) injections are not recommended for treatment of ACL tears, including as an adjunct at the time of reconstructive surgery.

Strength of evidence Moderately Not Recommended, Evidence (B)
Level of confidence Low

Rationale

Quality RCTs consistently report a lack of efficacy of PRP for treatment of ACL tears in the perioperative/postoperative period among the highest-quality studies (Darabos et al., 2011, Gong et al., 2022, Ye et al., 2024, Tripathy, 2025, Walters BL, 2018, Nin JR, 2009). Systematic reviews report the short-term changes are minor and do not meet the minimal clinically important difference (Cao et al., 2022, Pinho et al., 2025). There are multiple low-quality trials (Kumar et al., 2022, Sozkesen et al., 2018, Lin et al., 2024, Mirzatolooei et al., 2013,

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Cervellin et al., 2012). PRP is invasive, has some adverse effects, is high cost, and has evidence showing a lack of efficacy; thus, PRP is not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: platelet-rich plasma, plasma rich growth factor; posterior cruciate ligament tears, anterior cruciate ligament injuries, posterior cruciate ligament injuries, ACL, Anterior Cruciate ligament; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 74 articles in PubMed, 0 in CINAHL, 23 in Cochrane Library, 3280 in Google Scholar, and 0 from other sources†. We considered for inclusion 8 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 10 from Google Scholar, and 0 from other sources. Of the 18 articles considered for inclusion, 7 randomized trials and 11 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

HYALURONIC ACID INJECTIONS AFTER ACL SURGICAL REPAIR

Not Recommended

Hyaluronic acid injections are not recommended after ACL surgical repairs.

Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

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Two RCTs of hyaluronic acid injections after ACL repairs both found lack of durable benefits (Tripathy, 2025, Di Martino, 2016). Thus, these injections are not recommended for perioperative or postoperative use after ACL reconstruction.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: viscosupplementation, hyaluronic acid; posterior cruciate ligament tears, anterior cruciate ligament injuries, posterior cruciate ligament injuries, ACL, Anterior Cruciate ligament; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 26 articles in PubMed, 0 in CINAHL, 2 in Cochrane Library, 3890 in Google Scholar, and 0 from other sources†. We considered for inclusion 2 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 2 articles considered for inclusion, 2 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

SURGICAL CONSIDERATIONS

Surgery has been utilized for reconstruction of torn ACLs [898,899,905,920,922,929,1104,1105,1114-1158]. Recently, studies have documented equivalent success with non-operative management of ACL tears [1105]. The crossover rate to surgery from the non-operative arm was 37% (23 of 59), potentially signaling that significant numbers of patients may still require surgery for successful outcomes from ACL tears. There also are some concerns that meniscal injuries may occur more readily in cruciate deficient knees, and subsequent surgical repairs may be less successful [1159-1163].

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SURGERY FOR ANTERIOR CRUCIATE LIGAMENT (ACL) TEARS

Sometimes Recommended

Surgical reconstruction of ACL tears is selectively recommended for treatment of patients with ACL tears.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

The ACL tear should be confirmed on MRI. The surgical indications are: 1) Failure of a course of non-operative treatment (e.g., nonopioid analgesics, bracing, activity modifications, exercises (i.e., full range of motion and hamstring strengthening) and 2) minimum flexion of 110 degrees plus no significant effusion.

Patients should generally have attempted non-operative treatment that included progressive exercise implemented after the acute phase of swelling, if any, has subsided. Duration of a non-operative treatment plan to determine success or failure is unclear and likely requires individualization. A study evaluated grafting at 2 weeks versus 8 to 12 weeks and reported no significant differences at 52 weeks of follow up (Meighan et al., 2003). Most patients who fail non-operative treatment appear to require surgery within 3 months of the ACL tear (Frobell et al., 2010). There is no quality evidence surgery out-performs primary rehabilitation at 5 years of follow-up (Frobell et al., 2013). Some patients, particularly those with high demand jobs or high performance athletes, may be candidates for early surgical reconstruction, as they are believed to more frequently fail non-operative rehabilitation (Frank et al., 1997, Meighan et al., 2003). There is moderate-quality evidence that delay in surgical reconstruction does not impair outcomes (Frobell et al., 2010, Meighan et al., 2003); thus, quality studies have indicated no rush to operate.

Benefits

Theoretically better ability to suddenly pivot on the knee and less instability.

Harms

Approx. 67% increased risk of osteoarthritis in the operated knee, risk of infection, longer period of debility than with a primary rehabilitation approach.

Rationale

There are multiple moderate-quality trials comparing rehabilitation with surgical reconstruction of ACLs and report no differences over time intervals up to 5 years (Frobell et al., 2013, Frobell et al., 2010, Reijman et al., 2021, Vermeijden et al., 2023, Krause et al., 2018, Saueressig et al., 2022). However, one trial of repairs for late ACL tear presentations that had significant instability reported modest superiority of surgery compared with rehabilitation (Beard et al., 2024, Beard et al., 2022). Four remote, low-quality trials

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comparing surgical ACL reconstruction with nonoperative care have also been published, with one trial suggesting mostly comparable results but more instability in the non-surgical group (Andersson et al., 1991), one suggesting fewer subsequent meniscal tears after surgical ACL reconstruction (Meunier et al., 2007), one suggesting comparable functional outcomes (Odensten et al., 1985), and one suggesting superior stability with surgery (Andersson et al., 1992).

Data show that there is an ~67% increased risk of osteoarthrosis after 2,340 ACL reconstruction compared with non-operative management (Migliorini et al., 2023), including evidence as soon as one year after repair, raising further concerns about routine consideration for all patients (Culvenor et al., 2015).

There are numerous quality trials comparing many different surgical techniques. Patellar tendon autografts have been associated with fewer graft failures and less knee laxity. Hamstring tendon autografts have been associated with less anterior knee pain and less extension deficit (Ahlden et al., 2009, Yasuda et al., 2006, Anderson et al., 2001). Use of hamstring autograft compared to patellar reportedly results in less anterior knee pain up to 3 years post-operatively (Eriksson et al., 2001, Feller et al., 2001, Laxdal et al., 2005, Zaffagnini et al., 2006, Pigozzi et al., 2004, Pinczewski et al., 2007), and other studies reported no differences up to 7 years post-operatively (Ahlden et al., 2009, Liden et al., 2007, Webster et al., 2001, Carter et al., 1999, Harilainen et al., 2006).

Different hamstring autograft techniques have been used (Mohtadi et al., 2016, Murray et al., 2020, Schliemann et al., 2018, Zeng et al., 2016, Horstmann et al., 2022, Dai et al., 2016, Hoogeslag et al., 2019, Kösters et al., 2020, Lin et al., 2022, Li, 2022, Mo et al., 2020, Annear et al., 2019). There are studies evaluating the double-bundle technique versus the single-bundle technique (Wang et al., 2009, Sastre et al., 2010, Jarvela et al., 2008, Kanaya et al., 2009, Streich et al., 2008, Siebold et al., 2008, Yagi et al., 2007). The argument for the more technically demanding anatomic double-bundle technique is that the results are more anatomical compared to the single-bundle technique (Yasuda et al., 2006, Muneta et al., 2007, Zhao et al., 2007). Two moderate-quality studies comparing hamstring autograft double-bundle to single-bundle techniques reported superior anterior and rotational stability, but no subjective difference (Yasuda et al., 2006, Muneta et al., 2007). One study evaluated the double bundle hamstring autograft done with 4 strands versus 8, and reported superior outcomes in terms of laxity and subjective results in the 8-strand double-bundle group (Zhao et al., 2007). There is no clear evidence supporting one surgical treatment over another; thus there is no recommendation regarding specific autologous tendon harvest sites or surgical techniques. Currently available quality evidence suggests autologous grafting may be superior to prosthetics or allografts (Sun et al., 2009, Sun et al., 2009, Sun et al., 2009, Engstrom et al., 1993), although individual patient factors should be considered. This precludes a formal recommendation for or against prosthetics and allografts.

The combination of many RCTs showing no differences between operative and non-operative treatment suggests the potential population benefitted by ACL reconstruction or repair is limited to <50%; further, the sharply increased risks of OA should result in a well-informed discussion of the risks and benefits in a patient for decision making. Surgical

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reconstruction is invasive, has adverse effects including ~67% increased risk of osteoarthritis compared with non-operative management (Migliorini et al., 2023), and is high cost, but may be necessary for selected patients. Thus, it is selectively recommended for those who fail a non-operative treatment course (see Indications above).

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Surgery, Operation, Surgical procedure; posterior cruciate ligament tears, anterior cruciate ligament injuries, posterior cruciate ligament injuries, ACL, Anterior Cruciate ligament; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 6676 articles in PubMed, 13 in CINAHL, 1487 in Cochrane Library, 20600 in Google Scholar, and 0 from other sources†. We considered for inclusion 12 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 9 from Google Scholar, and 0 from other sources. Of the 21 articles considered for inclusion, 14 randomized trials and 7 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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REHABILITATION PROGRAMS

Exercise, physical therapy, and rehabilitation have been used for treatment of ACL tears either instead of surgery or post-operatively [144,1104,1105,1119,1120,1164-1171]. The early objectives of rehabilitation include restoration of knee range of motion, pain management, reduction of swelling, early ambulation and increasing muscle strength [1165,1168]. Return-to-activity estimates can be found in the relevant MDGuidelines Health Advisor topics, under "Length of Disability."

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PERTURBATION TRAINING FOR ACL INJURIES

Not Recommended

Perturbation training is not recommended as part of a comprehensive exercise program in patients with injured ACL with or without surgery.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

ACL injured patients who choose to undergo ACL reconstruction surgery, or patients who opt for nonsurgical management. To be done as part of a comprehensive exercise therapy program that includes strength training exercises (Fitzgerald et al., 2000, Hartigan et al., 2009).

Frequency/Dose/Duration

As part of a therapy program, both supervised and unsupervised. Available studies have examined up to 10 sessions of therapy with perturbation as a part of the therapy program (Fitzgerald et al., 2000, Hartigan et al., 2009).

Indications for discontinuation

Achievement of goals, non-compliance, or lack of benefits.

Rationale

A trial of the additive benefit of perturbation training in addition to balance, agility and strengthening exercises found no benefits at up to two years among young athletes, including in either gait improvements or reductions in ACL re-injuries (Capin et al., 2018, Capin et al., 2019, Johnson et al., 2020, Arundale et al., 2017, Arundale et al., 2018, Arundale et al., 2018). A low-quality study compared physical therapy with or without perturbation training and reported slightly better improvements in the perturbation group (Fitzgerald et al., 2000). Perturbation training can be included in a therapy program. Another low-quality study evaluated perturbation and strength training versus strength training alone prior to ACL surgery reported both groups increased strength post-operatively, but the group that included perturbation training had better gait mechanics results 6 months after surgery (Hartigan et al., 2009). As the sole quality trial suggests lack of efficacy, perturbation training is not recommended; nevertheless, it may be included in a postoperative rehabilitation program at essentially no cost.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Perturbation-based balance training, perturbation training, PBT; posterior cruciate ligament tears,

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anterior cruciate ligament injuries, posterior cruciate ligament injuries, ACL, Anterior Cruciate ligament; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 29 articles in PubMed, 0 in CINAHL, 17 in Cochrane Library, 4190 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 11 from Google Scholar, and 0 from other sources. Of the 11 articles considered for inclusion, 9 randomized trials and 2 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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REHABILITATION WITH OR WITHOUT ACL RECONSTRUCTION SURGERY

Recommended

Rehabilitation is recommended for treatment of ACL tears, with or without ACL reconstruction surgery.

Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Moderate

Indications

Rehabilitation for ACL tears is recommended for those with and without surgical repair. Rehabilitation as early as the first postoperative day is recommended for those undergoing surgery (Shaw et al., 2005, Bynum et al., 1995, Noyes et al., 1987).

Frequency/Dose/Duration

Two to 3 times a week for up to 6 weeks for guided therapy (Cooper et al., 2005, Olivier et al., 2009).

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Indications for discontinuation

Complications causing a need for further intervention and/or surgery.

Rationale

There are multiple moderate-quality trials comparing rehabilitation with surgical reconstruction of ACLs and report no differences over time intervals up to 5 years (Frobell et al., 2013, Frobell et al., 2010, Reijman et al., 2021, Vermeijden et al., 2023, Krause et al., 2018, Saueressig et al., 2022). However, one trial of repairs for late ACL tear presentations that had significant instability reported modest superiority of surgery compared with rehabilitation (Beard et al., 2024, Beard et al., 2022). Four remote, low-quality trials comparing surgical ACL reconstruction with nonoperative care have also been published, with one trial suggesting mostly comparable results but more instability in the non-surgical group (Andersson et al., 1991), one suggesting fewer subsequent meniscal tears after surgical ACL reconstruction (Meunier et al., 2007), one suggesting comparable functional outcomes (Odensten et al., 1985), and one suggesting superior stability with surgery (Andersson et al., 1992). Thus, there is quality evidence that non-operative management with rehabilitation is a successful treatment strategy and is recommended for most patients, although there are many exceptions (see surgical recommendations for further details).
All trials of early rehabilitation exercises showed efficacy (Shaw et al., 2005, Sekir et al., 2010) or trended towards early exercise benefits (Heijne et al., 2007). One of these evaluated isokinetic hamstring exercises as part of a postoperative rehabilitation program. One group started the exercises 3 weeks post-operatively, the other 9 weeks post-operatively. They reported benefits of starting exercises earlier in an athletic cohort (Sekir et al., 2010). A moderate-quality study compared patients who started quadriceps exercises on post-operative day 2 with patients who started therapy 1 to 2 weeks following surgery. They reported no increase in adverse events and faster recovery of knee range-of-motion and stability in the group that started therapy earlier (Shaw et al., 2005). Earlier rehabilitation has not been reported to increase adverse events, and it has been reported to increase benefits (Bynum et al., 1995). A systematic review concluded there is efficacy of early rehabilitation (Glattke et al., 2022).

Both of the quality RCTs comparing home-based vs. supervised programs found comparable results (Grant et al., 2005, Beard et al., 1998). Neuromuscular training was reportedly of additive benefit to rehabilitation (Risberg et al., 2007). Unilateral vs. bilateral resistance exercise reportedly resulted in minimal differences (Oliveira et al., 2022). One trial found some adjunctive value of an aquatic-based walking exercise to traditional PT, but it was subject to contact time and dose-of-exercise biases (Li et al., 2022). Trials conflict regarding the comparative value of open- vs. closed-chain exercises (Bynum et al., 1995, Morrissey et al., 2002). Many of the RCTs are low quality, typically with small sample sizes, sparse methods, lack of CONSORT diagrams, etc. (Guo et al., 2023, Zult et al., 2018, Zult et al., 2019, Harput, 2019, Ashour et al., 2024, Oestervemb et al., 2025, Gsangaya et al., 2023, Ogrodzka-Ciechanowicz et al., 2021, Chao et al., 2018, Karakoc et al., 2019, Vidmar et al., 2020).

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Rehabilitation including early rehabilitation is not invasive, has low adverse effects, is low cost, has documented efficacy, and is therefore recommended. The ideal content of the rehabilitation program's exercises remain to be established with quality RCTs.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Post-operative rehabilitation, early Post-operative rehabilitation; posterior cruciate ligament tears, anterior cruciate ligament injuries, posterior cruciate ligament injuries, ACL, Anterior Cruciate ligament; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 16 articles in PubMed, 0 in CINAHL, 9 in Cochrane Library, 1200 in Google Scholar, and 0 from other sources†. We considered for inclusion 4 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 13 from Google Scholar, and 0 from other sources. Of the 17 articles considered for inclusion, 13 randomized trials and 4 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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MENISCAL TEARS

TREATMENT RECOMMENDATIONS

ACTIVITY MODIFICATION AND EXERCISE

EXERCISES FOR MENISCAL TEARS

Sometimes Recommended

Exercise is selectively recommended for patients with meniscal tears, particularly after the acute phase and when there are deficits in strength.

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Strength of evidence Moderately Recommended, Evidence (B)
Level of confidence Low

Indications

Patients who are generally beyond the acute phase but who have significant limitations in strength. Strengthening exercises are also particularly indicated for workers who have early OA (see separate recommendation for knee osteoarthrosis).

Benefits

Improved strength and function.

Harms

Generally negligible, although significant aggravation is possible.

Frequency/Dose/Duration

Typically, 6-8 appointments are ordered. Additional sets of appointments should be based on ongoing deficits with failure to reach a healing plateau.

Indications for discontinuation

Completion of a course of therapy, resolution of pain, sufficient recovery to obviate the need for therapy and noncompliance.

Rationale

There are several quality trials of exercise therapy for treatment of patients with meniscal tears, most of which are trials comparing meniscectomy with exercise or therapy. Trials compared exercises with meniscectomy for subacute plus chronic patients (Katz et al., 2013), chronic patients (Skou et al., 2022, Kise et al., 2016, Yim et al., 2013), or patients with unspecified chronicity (van de Graaf et al., 2018). The studies reported no clear benefits of surgery (Skou et al., 2022, Damsted et al., 2023, Damsted et al., 2024, Clausen et al., 2025, Katz et al., 2013, Tuaki-Wosornu, 2016, Collins et al., 2020, Collins et al., 2022, van de Graaf et al., 2018, Noorduyn et al., 2020, Noorduyn et al., 2022, van de Graaf et al., 2016, Kise et al., 2016, Kise, 2019, Berg et al., 2020, Berg et al., 2022, Yim et al., 2013). Comparable results of lack of surgical superiority were reported in a trial assessing the additive benefit of meniscectomy to exercises (Herrlin et al., 2013, Herrlin et al., 2007). However, there was subsequent "marked" 4-fold acceleration of OA development in the surgery group in one of the trials (Collins et al., 2020), another noted advancing of MRI changes in the surgical group (van der Graaff, 2025), and one of the trials noted an approximately 5-fold risk of arthroplasty over 5-years (HR=4.9) among those treated with meniscectomy (Katz et al., 2020). One trial reported better short-term results with meniscectomy vs. exercises (Gauffin et al., 2014), but the study had nonsupervised exercises, only 53% returned exercise diaries, and the advantage of surgery was gone at 3-10 years of follow-up (Gauffin et al., 2017,

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Sonesson et al., 2020, Sonesson et al., 2024). Post-hoc analyses of one of the other trial suggested knee effusion and synovitis improved the benefits of early surgery (Clausen et al., 2025). A trial of telerehabilitation reported equivalency with a traditional program (He et al., 2025). There also are low-quality trials, primarily due to small sample size (Ericsson et al., 2009). Systematic reviews with meta-analyses suggest there is little measurable benefit from surgery vs. exercises across the RCTs (Wijn et al., 2023, Fernández-Matías et al., 2022). One weakness in the trials is the crossovers to surgery, although those not needing surgery still achieved mostly comparable results.

Thus, there is consistent evidence that exercise therapy is successful, has low/no adverse effects and is recommended. Exercise is thought to have a selective role in the treatment of patients with meniscal tears, as early exercises may potentially aggravate the pain; however, later prescription of exercise therapy may be helpful for those who have significant limitations in strength, as well as particularly for those workers who have early OA. Additional sets of appointments should be based on failure to meet a healing plateau while having objective deficits.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: exercise; torn meniscus OR meniscal tear; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 12 articles in PubMed, 47 in CINAHL, 5 in Cochrane Library, 18400 in Google Scholar, and 0 from other sources†. We considered for inclusion 10 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 22 from Google Scholar, and 0 from other sources. Of the 32 articles considered for inclusion, 27 randomized trials and 5 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

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WORK LIMITATIONS FOR SELECT CASES OF MENISCAL TEARS

Recommended

Work limitations are recommended for those with meniscal tears performing high physical demand tasks or those who have no ability to avoid repeating physically demanding job tasks that may have resulted in the condition.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Work limitations may be needed for some workers, especially when symptoms are more severe and/or the job demands provoke significant symptoms. Many cases of meniscal tears require no limitations, especially where job demands are low.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Work limitation; tibial meniscus injuries, torn meniscus OR meniscal tear; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 29 articles in PubMed, 0 in CINAHL, 2 in Cochrane Library, 18,400 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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INJECTION THERAPIES

Platelet rich plasma, as well as autologous blood injections, have been used to treat several tendinopathies including lateral epicondylalgia [1172,1173]. Achilles' tendinopathies [1174,1175], and patellar tendinopathy [1176,1177]. These injections have also been used for treatment of osteoarthritis [828,829,830,831,1178,1179,1180]. Glucocorticosteroid injections also have been used to treat meniscal tears [1181].

PLATELET-RICH PLASMA AND AUTOLOGOUS BLOOD INJECTIONS FOR MENISCAL TEARS

Not Recommended

Platelet-rich plasma or autologous blood injections are not recommended for treatment of meniscal tears.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

There are few trials of the use of PRP for the treatment of meniscal tears. The highest-quality trial suggested a lack of efficacy (Lo Presti et al., 2024). There are multiple low-quality studies, with small sample sizes and methodological weaknesses (Lin et al., 2020, Elnemr et al., 2019, Shayan et al., 2025, Kaminski R, 2018, Kaminski et al., 2019). Multiple systematic reviews noted the weaknesses of the literature (Gopinatth et al., 2024, Utrilla et al., 2024, Elphingstone et al., 2024). Because most of the limited literature is low quality, the highest quality study is negative, there is no quality evidence of durable benefits, and these injections are high-cost, PRP injections and autologous blood injections are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: platelet-rich plasma, plasma rich growth factor; torn meniscus OR meniscal tear; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 18 articles in PubMed, 13 in CINAHL, 16 in Cochrane Library, 6480 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 14 from Google Scholar, and 0 from other sources. Of the 14 articles considered for inclusion, 5 randomized trials and 9 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the

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present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

GLUCOCORTICOSTEROID INJECTIONS FOR MENISCAL TEARS

Not Recommended

Glucocorticosteroid injections are not recommended for the treatment of meniscal tears.

Strength of evidence Not Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

There is no quality evidence of efficacy of these injections for meniscal tears and thus they are not recommended. There are other indications for the selective use of glucocorticosteroid injections.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: intraarticular injections, glucocorticosteroid injections, corticosteroid injections; torn meniscus OR meniscal tear; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 34 articles in PubMed, 11 in CINAHL, 0 in Cochrane Library, 11000 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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SURGICAL CONSIDERATIONS

Surgical partial meniscectomy has been used for treatment of meniscal tears [1182-1190], particularly by arthroscopic means [1191-1213]. The short-term prognosis [1214,1215], as well as the degree of subsequent arthrosis has been correlated with the amount of meniscus removed [322,1191,1216,1217,1218]. Meniscal repairs have a higher operation rate than partial meniscectomies; however, reportedly more likely result in better long-term outcomes [1219]. All-inside repair has been utilized as a surgical technique [1220,1221,1222]. There also are concerns that a lateral meniscus tear may have a worse prognosis [1194]. However, a Cochrane review concluded the lack of RCTs impaired the ability to draw conclusions regarding surgical versus non-surgical management as well as repair versus excision of torn menisci. There also are investigational techniques, including use of stem cells to attempt to regenerate menisci [1223,1224,1225]. Allograft transplantation [1226-1250], collagen implants [1251,1252], and synthetic materials [1253] have also been utilized.

SURGERY FOR MENISCAL TEARS

Sometimes Recommended

Arthroscopic partial meniscectomy and meniscal repairs are recommended for highly select patients with symptomatic torn menisci.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Potentially, operative meniscal tear(s) should be confirmed by: 1) x-ray ruling out significant degenerative joint disease and 2) imaging studies (e.g., MRI, ultrasound) or surgical findings consistent with meniscal tear. The surgical indication is: 1) Failure of a course of non-operative treatment (e.g., nonopioid analgesics; ice/heat; activity modifications; progressive rehabilitative exercises; ace wraps, supports or sleeves) (i.e., at least 4 weeks without improvement and/or without trending towards resolution).

Relatively few patients with meniscal tears appear to be candidates for this surgery. Possible expectations include those with locking symptoms, severe tears, and/or frank traumatic onset that does not generally include onset after “exercise,” “hard work,” or “twisting” events (Sihvonen et al., 2013). Thus, patients should be highly selected and have attempted non-operative treatment that generally included passage of at least a few weeks, NSAIDs, and activity modulation, and also may have included formal therapy (Herrlin et al., 2007). Patients with marked mechanical symptoms (e.g., mechanical locking with effusions) are

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candidates for early operative intervention. Patients trending towards improvement generally warrant longer periods of non-operative management, while patients failing to trend towards improvement over at least 3 to 4 weeks are candidates for earlier surgical treatment.

Radial tears that transect the principal circumferential collagen fibers of the meniscus are also an indication for surgical repair if there is sufficient tissue quality and tear location to permit restoration of native mechanics.

Benefits

Theoretical potential for faster healing, but limited to those who would not have healed or recovered without surgery.

Harms

Inherent risks of surgery, including infection and postoperative debility. There also are multiple reports of increased risk of knee arthritis after surgery (Collins et al., 2020, van der Graaff, 2025, Berg, 2024, Kalske R, 2026).

Rationale

There is one high-quality trial comparing partial meniscectomy with sham in knees without osteoarthrosis, which found a lack of efficacy including at 2-year follow-up (Sihvonen et al., 2013, Sihvonen et al., 2018). There are several quality trials of exercise therapy vs. meniscectomy for treatment of patients with meniscal tears, with no clear benefits reported for surgery (Skou et al., 2022, Damsted et al., 2023, Damsted et al., 2024, Clausen et al., 2025, Katz et al., 2013, Tuaki-Wosornu, 2016, Collins et al., 2020, Collins et al., 2022, van de Graaf et al., 2018, Noorduyn et al., 2020, Noorduyn et al., 2022, van de Graaf et al., 2016, Kise et al., 2016, Kise, 2019, Berg et al., 2020, Berg et al., 2022, Yim et al., 2013). Comparable results of lack of surgical superiority were reported in a trial assessing the additive benefit of meniscectomy to exercises (Herrlin et al., 2007, Herrlin et al., 2013).

However, there was subsequent "marked" 4-fold acceleration of OA development in the surgery group in one of the trials (Collins et al., 2020), and another noted advancing of MRI changes in the surgical group (van der Graaff, 2025). Ten-year follow-up of two of those trials showed more arthritis development in the surgical groups (Berg, 2024, Kalske R, 2026). One trial noted an approximately 5-fold risk of arthroplasty over 5-years (HR=4.9) among those treated with meniscectomy (Katz et al., 2020). One trial reported better short-term results with meniscectomy vs. exercises (Gauffin et al., 2014), but the study had non-supervised exercises, only 53% returned exercise diaries, and the advantage of surgery was gone at 3-5-10 years of follow-up (Gauffin et al., 2017, Sonesson et al., 2020, Sonesson et al., 2024). Post-hoc analyses of another trial suggested knee effusion and synovitis improved the benefits of early surgery (Clausen et al., 2025). There are many low-quality studies (Thorblad et al., 1985, Petersen et al., 1996, Hamberg et al., 1984, Graf et al., 1996). Systematic reviews with meta-analyses suggest there is little measurable benefit from surgery vs. exercises across the RCTs (Wijn et al., 2023, Fernández-Matías et al., 2022). One

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weakness in the trials is most trials report crossovers to surgery, although those not needing surgery still achieved mostly comparable results.

As noted above, meniscal degenerative tears become universal with age. These data also suggest that there are many cases of meniscal tears that do not require meniscectomy. Additionally, surgical indications have not been clearly defined. Those with marked mechanical symptoms have not been evaluated in randomized, quality trials and are believed to require operative treatment. Meniscal repairs have a higher re-operation rate than partial meniscectomies; however, reportedly more likely result in better long-term outcomes (Paxton et al., 2011). One moderate-quality trial suggested a radiofrequency device was superior to a mechanical shaver to accomplish the meniscectomy (Spahn et al., 2008).

Surgery is invasive, has adverse effects, is costly, and the highest quality evidence does not support efficacy; but surgery is thought to be required for treatment of selected meniscal tears, particularly those including significant mechanical symptoms. Surgery is thus highly selectively recommended.

Additionally, radial meniscal tears that transect the principal circumferential collagen fibers substantially impair hoop-stress transmission and, when tissue quality and tear location permit restoration of native mechanics, are an indication for repair. Failure to recognize and address consequent meniscal root insufficiency has been associated with accelerated compartmental osteoarthritis and an increased likelihood of subsequent total knee arthroplasty.

Available evidence suggests that preservation of more meniscal tissue is superior to removal of greater quantities of the menisci for both short- to intermediate-term function (Lee et al., 2025)(Petersen et al., 1996, Hamberg et al., 1984, Rodkey et al., 2008, Hede et al., 1986, Hede et al., 1992, Hede et al., 1992), as well as for reduction in subsequent risk of osteoarthrosis (Migliorini et al., 2023)(Englund et al., 2001, Andersson-Molina et al., 2002, Lanzer et al., 1990, McDermott et al., 2006, Meredith et al., 2005). There is no quality evidence to address utility of meniscectomy by peripheral/vascular vs. avascular zone involvement, although there are opinions about these tears (Perdue et al., 1996, Barrett et al., 1998, Boyd et al., 2003, Noyes et al., 2000).

There is no quality literature on the utility of meniscal allograft transplantation (Smith et al., 2016, Smith et al., 2018); thus, there is no recommendation for or against allograft transplantation.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: surgery, meniscus surgery; torn meniscus OR meniscal tear; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 470 articles in PubMed, 32 in CINAHL, 112 in

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Cochrane Library, 1700 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 7 from Google Scholar, and 0 from other sources. Of the 7 articles considered for inclusion, 2 randomized trials and 5 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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REHABILITATION PROGRAMS

Exercise, physical therapy, and rehabilitation have been used for treatment of meniscal tears [1254,1255,1256].

MENISCAL TEAR REHABILITATION AFTER SURGICAL REPAIR

Sometimes Recommended

Meniscal tear rehabilitation is recommended for select patients after surgical repair.

Strength of evidence Recommended, Evidence (C)
Level of confidence Low

Indications

Patients with meniscal tears having undergone surgical repair, particularly with functional deficits such as residual muscle weakness.

Frequency/Dose/Duration

One to 6 weeks, 2 to 3 sessions a week.

Indications for discontinuation

Achievement of goals, non-compliance with clinic or home-based exercises or intolerance.

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Rationale

Some trials have suggested exercise is superior to no post-meniscectomy rehabilitation, with benefits persisting to 12 months of follow-up (Osteras, 2014, Osteras, 2014). Most trials of exercise and rehabilitation enrolled post-meniscectomy patients (Karumo, 1977). Most of these trials compared supervised therapy with either a home exercise program or advice compared to a home program (Goodwin et al., 2003), physiotherapy with oral and written advice (Vervest et al., 1999), and stationary bicycling with no treatment (Kelln et al., 2009). One trial found functional strengthening exercises superior to a control for post-operative rehabilitation (Ericsson et al., 2009). One trial did not find an exercise program as superior to no program (Hall et al., 2015). There are low-quality studies, mostly with small sample sizes (Osteras, 2014, Moffet et al., 1994). Thus, the balance of studies implies the post-operative results are good and that many patients do not appear to require formal post-operative therapy aside from advice and education.

Nevertheless, exercise is thought to be helpful for select patients with weakness or other functional limitations who were not the main enrollment criteria for the available evidence-base. Some may require few appointments for teaching while others require more supervision and assistance with advancement of the program towards independence in the presence of significant deficits. Exercise is not invasive, has low adverse effects and is moderately costly, depending on numbers of appointments required, and is recommended for select patients with functional deficits.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Rehabilitation; torn meniscus OR meniscal tear; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 81 articles in PubMed, 62 in CINAHL, 66 in Cochrane Library, 5690 in Google Scholar, and 0 from other sources†. We considered for inclusion 5 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 5 articles considered for inclusion, 5 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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KNEE BURSITIS

OVERVIEW

Knee bursitis is usually associated with a painless effusion of one or more of the knee bursae [1257,1258,1259,1260]. Acute knee bursitis may be slightly warm, but is generally non-tender or minimally tender. Septic (infected) bursitis is either a complication of aseptic knee bursitis or a direct consequence of trauma [365,1257,1261,1262]. Generally, to be a complication of aseptic knee, bursitis also requires introduction of organisms through the skin, such as via abraded skin or an injection, although systemic seeding may also occur. Signs include swelling, pain, tenderness, and pain on range of motion [1257,1258,1260,1263]. Bursitis due to crystal arthropathies also tends to present with findings similar to those of septic bursitis [1258,1264].

TREATMENT RECOMMENDATIONS

ACTIVITY MODIFICATION AND EXERCISE

ACTIVITY MODIFICATION TO AVOID KNEELING OR PRESSURE FOR KNEE BURSITIS

Recommended

Modifying activities to avoid kneeling or pressure over the knee and allowing time to reabsorb the fluid are recommended for treatment of knee bursitis.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

There are no quality trials evaluating modification of activities for treatment of knee bursitis. Most cases appear to resolve with non-invasive options including avoiding kneeling and pressure on the knee. Activity modification is not invasive, has low or no adverse effects, is low cost, and is therefore recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: modifying activities; Bursitis, knee bursitis, prepatellar bursitis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 9 articles in PubMed, 0 in CINAHL, 2 in

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Cochrane Library, 13,200 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trial and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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INJECTION THERAPIES

Injection with a glucocorticosteroid (typically doses of methylprednisolone approximately 20 to 40mg or equivalent), often accompanied by aspiration, is widely used for aseptic knee bursitis [1265].

GLUCOCORTICOSTEROID INJECTIONS FOR KNEE BURSITIS

No Recommendation

There is no recommendation for or against the use of glucocorticosteroid injections for the treatment of knee bursitis. This may be a reasonable option for patients who are failing to resolve prior to consideration of surgery.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

There are no quality studies evaluating the use of glucocorticosteroid injections to treat knee bursitis. A trial compared glucocorticosteroid injection with extracorporeal shockwave treatments and reported superiority of ESWT (Farsad et al., 2023). These injections sometimes appear to help speed resolution in cases not trending towards resorption. However, these injections with glucocorticoids potentially introduce bacteria, thus the one drawback is they may create a septic bursitis, which then often requires surgical drainage.

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If attempted, these injections appear to be reserved for patients thought to not be infected and/or who are not resolving with activity modifications and observation. If attempted, generally only one aspiration/injection is performed, followed by careful observation. Some physicians aspirate and then inject, while others only inject the steroid. If the bursitis is not satisfactorily resolved, a second aspiration/injection is often attempted, although usually not sooner than 3 to 4 weeks later. Doses of steroid are approximately, e.g., methylprednisolone 20 to 40mg or equivalent. Aspirated fluid should be sent at least once for studies including crystals (light polarizing microscopy), Gram stain, culture, sensitivity, and complete cell count.

Glucocorticosteroid injection is invasive, has relatively low adverse effects, although it can introduce an infection, and is moderately costly; thus, it is recommended in those cases not trending towards resolution.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Glucocorticosteroid injections; knee bursitis, bursitis, prepatellar bursitis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 0 articles in PubMed, 0 in CINAHL, 0 in Cochrane Library, 2830 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trial and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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SURGICAL CONSIDERATIONS

Surgery has been used to treat knee bursitis that has not responded to activity modifications and injections or if infection is believed to be present [1266-1270]. Aspiration of the swollen bursa has been used for diagnosing septic knee bursitis, or if it is thought to be potentially infected [1258,1260,1265].

ASPIRATION FOR INFECTED BURSA

Recommended

Aspiration of a clinically infected or questionably infected bursa is recommended.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

Aspiration has been used for diagnosis, particularly when combined with Gram stain, culture and sensitivity, and complete cell count of the aspirated fluid are performed. Crystal examination (light polarizing microscopy) should also be performed at least once on the aspirated fluid. Aspiration of a bursa is invasive, has relatively low adverse effects (although it can introduce an infection), and is low to moderately costly, but is recommended for diagnosis and planning of treatment.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Aspiration; Bursitis, knee bursitis, prepatellar bursitis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 11 articles in PubMed, 8 in CINAHL, 3 in Cochrane Library, 8580 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles,

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we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

SURGICAL DRAINAGE FOR KNEE BURSITIS

Recommended

Surgical drainage is recommended for treatment of knee bursitis that is infected or otherwise not trending towards resolution.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Knee bursitis that is either infected, clinically thought to be infected, or not infected but present for at least approximately 6 to 8 weeks without trending towards resolution despite being treated with soft padding and activity modifications.

Rationale

There are no quality trials addressing surgery for the treatment of knee bursitis. Surgical drainage of a swollen knee bursa has been successfully used for treatment. As it is not without potential complications, it is recommended to be reserved for selected cases either involving infection or failure to respond to an adequate trial of non-operative measures. Surgical drainage is invasive, has modest adverse effects, and is moderately to highly costly, but is recommended in those cases not trending towards resolution or which are thought to be infected.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: surgery; Bursitis, knee bursitis, prepatellar bursitis; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 429 articles in PubMed, 52 in CINAHL, 38 in Cochrane Library, 18,100 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full

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evidence base used in this guideline includes all relevant studies identified without date constraints.

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PATELLAR TENDINOSIS, PATELLAR TENDINOPATHY ("JUMPER'S KNEE"), AND ANTERIOR KNEE PAIN

OVERVIEW

Anterior knee pain is caused by several different entities that include patellar tendinosis as well as patellofemoral joint-related pain [370,414,1271,1272]. The tendinopathy may be either proximal or distal [1273]. The diagnosis is primarily clinical (see History and Physical Examination), and a careful history will usually result in a presumptive diagnosis that may be confirmed with physical examination. Patients have anterior knee pain, and those with patellar tendinosis have pain localized to the affected area of the patellar tendon. Those with patellofemoral joint disorders tend to have peripatellar knee pain that often is worse with use of stairs [1271,1274]. Framingham study data (n=1,137 knees) show that knee pain is associated with either lateral patellofemoral cartilage loss or bone marrow lesions, while there is no association between pain and isolated medial PF joint loss [1275].

TREATMENT RECOMMENDATIONS

ACTIVITY MODIFICATION AND EXERCISE

Rest, splints, ice, and heat have been utilized for treatment of tendinoses, as well as for patellofemoral joint disorders. There are no quality studies of treatment options, aside from surgery and rehabilitation for patellofemoral pain or tendinosis (see next section). Out of necessity, guidance for treatment relies upon other musculoskeletal disorders for inferences on projected treatment efficacy.

Exercise, physical therapy, and rehabilitation have been used for treatment of anterior knee pain [1276-1299]. However, evidence to support physical interventions has been labeled "limited" [1300].

EXERCISE FOR PATELLOFEMORAL JOINT PAIN

Recommended

Exercise is recommended for patellofemoral joint pain.

Strength of evidence Recommended, Evidence (C)
Level of confidence Low

Indications

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Patients with patellofemoral joint pain, especially if insufficiently responsive to treatment with NSAIDs and activity modification.

Benefits

Improved pain and function.

Harms

Negligible.

Frequency/Dose/Duration

One to 4 weeks, 2 to 3 sessions a week; additional appointments based on continuing objective improvements.

Indications for discontinuation

Achievement of goals, non-compliance with clinic or home-based exercises, intolerance.

Rationale

Multiple moderate-quality trials compared exercise therapy with no treatment and found exercise modestly beneficial (van Linschoten R et al., 2009, van Linschoten et al., 2006, Syme et al., 2009). One trial reported no short-term differences or differences at 1 year in comparing education plus isolated hip-focused exercise, traditional knee-focused exercise, or free physical activity (Hott A, 2019, Hott et al., 2020). Four more moderate quality trials also found no differences in outcomes measures between hip and knee-focused exercises (Hansen et al., 2023, Ferber et al., 2015, Avraham et al., 2007, Witvrouw et al., 2003). Another trial found hip exercises of additive benefit to knee exercise, although the attentional/contact time biases somewhat limit the strength of the conclusion (ŞAHİN, 2016) and another trial found hip exercises of no additive benefit to knee exercises (Song et al., 2009).

One comparative trial suggested a patellar brace is of equal efficacy (Lun et al., 2005). One high-quality trial with two reports included multiple co-interventions and suggested benefit, but an assessment of which intervention was effective is not possible (Crossley et al., 2002, Crossley et al., 2005, Cowan et al., 2002, Roush et al., 2000). One trial adding whole body vibration to exercises found modest additive benefits, although the attentional bias limits the strength of the conclusion (Yañez-Álvarez et al., 2020). Trials have conflicted regarding superiority of open v closed chain exercises (Witvrouw et al., 2000, Witvrouw et al., 2004). Results from another trial of specific exercise approaches, including static, dynamic, vastus medialis obliquus selective activation (VMO), is unclear (Syme et al., 2009). One trial suggested additive benefit of EMG-biofeedback to isometric exercises (Alonazi et al., 2021). However, a few trials suggest no superiority of exercises (Quilty et al., 2003).

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Multiple low-quality and excluded trials have weaknesses that include small sample size, lack of baseline data, and a lack of CONSORT diagrams (Scafoglieri et al., 2021, Kamel et al., 2024, Saad et al., 2018, da Silva Boitrago et al., 2021, Hong et al., 2023, Xiong et al., 2025, Bagheri et al., 2021, Albornoz-Cabello et al., 2023, Sprague et al., 2021, Nakagawa et al., 2008, Herrington et al., 2007, Cannell et al., 2001, Bakhtiary et al., 2008). A systematic review concluded that "exercise prescriptions in RCTs with proven efficacy for PFP are poorly reported, impairing their implementation in clinical practice" (Holden et al., 2018).

Exercises are not invasive, have low adverse effects, are low to moderate cost depending on numbers of appointments, and with some quality evidence suggestive of efficacy, are thus recommended. Evidence supports prescriptions of exercises that are knee- and/or hip-focused.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Exercise; Tendinopathy, patellar tendinosis, patellar tendinopathy, jumper's knee, patellofemoral pain syndrome, anterior knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 300 articles in PubMed, 271 in CINAHL, 16 in Cochrane Library, 13,900 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 15 from Google Scholar, and 0 from other sources. Of the 15 articles considered for inclusion, 13 randomized trials and 2 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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WORK LIMITATIONS FOR SELECT CASES OF PATELLOFEMORAL JOINT PAIN

Recommended

Work limitations are recommended for select patients with patellofemoral joint pain who have significantly increased symptoms from the performance of physically demanding tasks or who have no ability to avoid repeating physically demanding job tasks that have resulted in the condition, especially jumping for patellar tendinosis and stair use for patellofemoral joint pain.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Rationale

There are no quality studies addressing the utility of work limitations. Work limitations may be clinically necessary depending on a combination of the severity of the condition and the required job demands. Those who have significantly increased symptoms from the performance of physically demanding tasks or who have no ability to avoid repeating physically demanding tasks that have resulted in the condition are recommended to have work limitations. In other cases, there is no recommendation for or against work limitations.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Work limitation, work restriction; Tendinopathy, patellar tendinosis, patellar tendinopathy, jumper's knee, patellofemoral pain syndrome, anterior knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 76 articles in PubMed, 0 in CINAHL, 17 in Cochrane Library, 9080 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

DEVICES

Patellar taping has been used to treat anterior knee pain [1301,1302,1303]. There is experimental evidence supporting the idea that taping and bracing provide coronal plane and torsional control of the knee in eccentric stair step descent [684]. Orthotics have been used for treatment of patellofemoral joint pain [1304,1305,1306,1307,1308].

TAPING OR KINESIOTAPING FOR ANTERIOR KNEE PAIN

Not Recommended

Taping is not recommended for anterior knee pain.

Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

Two moderate-quality trials, including one attempting sham taping and found no efficacy of taping (Hinman et al., 2003, Clark et al., 2000). While one trial suggested taping in a military population may be superior (Whittingham et al., 2004), the balance of studies suggest that it is not effective. There were two crossover trials, but both were of very short duration, precluding their use in guidance (Cowan et al., 2002, Cushnaghan et al., 1994). Two low-quality studies suggested lack of efficacy (Günay, 2017, Kowall et al., 1996). One trial suggested EMG-biofeedback training was adjunctive to isometric exercises, however while the taping was different between the two groups, the co-interventions prevention strong conclusions (Alonazi et al., 2021). There are many low quality and excluded studies with weaknesses typically including small sample sizes, lack of baseline data and/or lack of CONSORT diagrams (Whittingham et al., 2004, Cowan et al., 2002, Cushnaghan et al., 1994, Kowall et al., 1996, Hasan et al., 2022, Arrebola et al., 2020, Demirci et al., 2017, Melo et al., 2020, Songur et al., 2024, de Vries et al., 2016, Ghourbanpour et al., 2018).

Taping is not invasive, is not tolerated by some patients and compliance is reportedly problematic. There are significant concerns about mechanism of action to affect deep muscle tissue. Taping is low cost for one application, but rapidly becomes costly over time. As the higher quality evidence suggests a lack of efficacy, taping is not recommended for treating anterior knee pain or patellar tendinopathy.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Taping; Tendinopathy, patellar tendinosis, patellar tendinopathy, jumper's knee, patellofemoral pain syndrome, anterior knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized,

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randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 26 articles in PubMed, 44 in CINAHL, 11 in Cochrane Library, 2940 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 13 from Google Scholar, and 0 from other sources. Of the 13 articles considered for inclusion, 11 randomized trials and 3 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ORTHOTICS OR KNEE SPLINTS FOR PATELLOFEMORAL KNEE PAIN

No Recommendation

There is no recommendation for or against the use of orthotics, braces, splints or wraps for patellofemoral joint pain.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

One RCT suggested a patellar brace is of equal efficacy as compared with exercises (Lun et al., 2005). There are many low quality and excluded trials that have problems including low sample size, lack of baseline data to assess comparability, lack of CONSORT diagrams and other weaknesses that impair their utility (Priore et al., 2020, Mølgaard et al., 2018, Alshaharani et al., 2020, Petersen et al., 2016, Uboldi et al., 2018). There also are experimental trials and other studies measuring kinesmatics and not utility of the device for patients with assessment of meaningful outcomes measures (Kölle et al., 2020, Callaghan et al., 2016, Merino et al., 2021). A Cochrane review concluded the overall evidence for orthotics was "very low quality" and that there was "a lack of evidence to inform on the use of knee orthoses for treating PFPS" (Smith et al., 2015). While that review was performed

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over a decade ago, this systematic review has not found quality evidence to materially overturn that conclusion.

There is one moderate-quality study comparing bracing with no bracing in prevention of anterior knee pain in military recruits and that study reported a significant decrease in the development of anterior knee pain after 6 weeks (Van Tiggelen et al., 2004). There is one quality trial comparing foot orthoses, flat inserts, physiotherapy and a combination of foot orthoses plus physiotherapy and found minimal differences suggesting lack of efficacy (Collins et al., 2008).

Orthotics, braces, splints, wraps and sleeves are not invasive, have few adverse effects, range from low to high cost depending on the product and customization. As there is an absence of quality evidence of efficacy, the moderate to high cost devices are not recommended and there is no recommendation regarding the use of low cost devices.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Orthotics, braces, sprints | wraps; Tendinopathy, patellar tendinosis, patellar tendinopathy, jumper's knee, patellofemoral pain syndrome, anterior knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 238 articles in PubMed, 31 in CINAHL, 7 in Cochrane Library, 2060 in Google Scholar, and 0 from other sources†. We considered for inclusion 1 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 0 from Google Scholar, and 0 from other sources. Of the 1 article considered for inclusion, 1 randomized trial and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ALLIED HEALTH INTERVENTIONS

Extracorporeal shockwave therapy (ESWT) has been utilized for treatment of tendinoses, especially in the shoulder and ankle. It has been documented to have efficacy for treatment of calcific tendinitis in the shoulder (see Shoulder Disorders guideline) [1309,1310,1311,1312,1313,1314]. Acupuncture has been used for treatment of anterior knee and patellofemoral pain [1315,1316]. Manipulation and mobilization and have been used to treat anterior knee pain, often in conjunction with axial joints [744,1317,1318,1319,1320]. Electrical stimulation has been used for treatment of anterior knee pain [775].

EXTRACORPOREAL SHOCKWAVE THERAPY FOR PATELLAR TENDINOSIS

Not Recommended

Extracorporeal shockwave therapy is not recommended for treatment of patellar tendinosis.

Strength of evidence Moderately Not Recommended, Evidence (B)
Level of confidence Moderate

Rationale

One sham-controlled trial found a lack of efficacy of ESWT for treatment of patellar tendinopathy in active athletes (Zwerver J, 2011) and another trial found a lack of effectiveness for adding ESWT to eccentric exercises (Thijs KM, 2017). One sham-controlled trial found radial but not focused ESWT to be effective (Sah, 2023), yet another trial found no difference between focused ESWT and radial shockwave therapy (van der Worp H, 2014). There is one low-quality trial comparing extracorporeal shockwave therapy with either sham or low-energy treatment for patellar tendinosis (Wang et al., 2007). There are two trials suggesting ESWT is inferior to platelet-rich plasma injections (see above). For most body parts, there is evidence that ESWT is ineffective (see Elbow Disorders, Shoulder Disorders, and Ankle and Foot Disorders guidelines), with the primary exception being efficacy for the treatment of calcific rotator cuff tendinosis. There are multiple low quality and excluded trials with weaknesses typically including small sample size, lack of baseline comparability and lack of CONSORT diagrams (Taunton et al., 2002, Wang et al., 2007, Zhang et al., 2020, Jhan et al., 2024, Persson Krogh et al., 2021). Systematic reviews have concluded there is evidence of a lack of efficacy of ESWT for patellar tendinopathy (Charles et al., 2023, Guo et al., 2025).

ESWT is minimally invasive, is often performed with an injected anesthetic, has some adverse effects, is moderate to highly costly depending on numbers of treatments, and most placebo-controlled trials showing lack of efficacy and thus it is not recommended. Additional RCTs especially addressing the utility and durability of radial ESWT are needed.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Extracorporeal shockwave therapy; Tendinopathy, patellar tendinosis, patellar tendinopathy, jumper's knee, patellofemoral pain syndrome, anterior knee pain; controlled clinical trial, controlled

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trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 141 articles in PubMed, 60 in CINAHL, 1 in Cochrane Library, 3,230 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 11 from Google Scholar, and 0 from other sources. Of the 11 articles considered for inclusion, 5 randomized trials and 6 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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ELECTRICAL STIMULATION FOR ANTERIOR KNEE PAIN

Not Recommended

Neuromuscular electrical stimulation is not recommended for treatment of anterior knee pain.

Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

There are no quality placebo- or sham-controlled clinical trials evaluating neuromuscular electrical stimulation for anterior knee pain. One moderate quality trial in a military population suggested that adding NMES or TENS to a home exercise program was superior to only a HEP (Talbot et al., 2020), yet another trial found electrical stimulation to be of no added benefit in addition to exercises (Bily et al., 2008). Another moderate-quality trial that used two different active treatments failed to find differences (Callaghan et al., 2004). There are multiple low-quality and excluded studies with small sample sizes, lack of baseline data, sparse methodological details and lack of CONSORT diagrams (Kumar et al., 2022, Das et al., 2016, Nie et al., 2024, Glaviano et al., 2020, Melo et al., 2024).

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A Cochrane review found the overall evidence "very low" and "insufficient and inconclusive evidence" to inform on the role of NMES for treating patellofemoral syndrome (Martimbianco et al., 2017). This systematic review did not yield added and newer information to overturn that conclusion.

Electrical stimulation is not invasive, has low adverse effects, and is moderately costly. It appears ineffective in most studies for the treatment of patellofemoral syndrome/anterior knee pain and thus is not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Electric Stimulation Therapy, pulsed electromagnetic therapy, neuromuscular electrical therapy; Tendinopathy, patellar tendinosis, patellar tendinopathy, jumper's knee, patellofemoral pain syndrome, anterior knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 73 articles in PubMed, 3 in CINAHL, 1 in Cochrane Library, 513 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 9 from Google Scholar, and 0 from other sources. Of the 9 articles considered for inclusion, 7 randomized trials and 2 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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DRY NEEDLING FOR PATELLAR TENDINOPATHY

No Recommendation

There is no recommendation regarding dry needling for treatment of patellar tendinopathy.

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Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

Rationale

A trial of dry needling to the patellar tendon that targeted degenerative areas on US reported benefits, although there was only 4 weeks of follow-up (Sharif et al., 2022). Another comparative trial of dry needling, percutaneous needle electrolysis and eccentric exercise found comparable (in)efficacy and noted evidence of placebo and nocebo effects from needling (López-Royo et al., 2021). A low-quality trial of tenotomy vs. tenotomy plus PRP injection found no adjunctive benefits of the PRP injection (Kirschner et al., 2021).

Trials of dry needling to muscle trigger points around the knee conflict regarding efficacy (Espí-López et al., 2017, Ma et al., 2020). There is one moderate-quality study suggesting superiority of PRP over dry-needling (Dragoo et al., 2014).

There are multiple low quality and excluded trials with weaknesses that include small sample size, baseline non-comparability and lacking CONSORT diagrams (López-Royo et al., 2021, Qureshi et al., 2025, Doménech-García et al., 2024, Safavi et al., 2025, Ishtiaq et al., 2025). As well, one experimental trial reported lack of efficacy of muscle needling, but there was only 72 hours of follow-up (Sutlive et al., 2018).

Dry needling is minimally invasive, has few adverse effects, is moderate to high cost depending on numbers of treatments. Because evidence is unclear regarding efficacy for targeting either the patellar tendon of muscles, and follow-ups have been of inadequate length, there is no recommendation.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Dry needling, percutaneous needle tenotomy; Tendinopathy, patellar tendinosis, patellar tendinopathy, jumper's knee, patellofemoral pain syndrome, anterior knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 65 articles in PubMed, 38 in CINAHL, 4 in Cochrane Library, 288 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 13 from Google Scholar, and 0 from other sources. Of the 13 articles considered for inclusion, 8 randomized trials and 5 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full

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INJECTION THERAPIES

Platelet-rich plasma, as well as autologous blood injections, have been used to treat several tendinopathies including patellar tendinopathy [1176,1177]. These injections have also been used for treatment of osteoarthritis [828,829,830,831,1178,1179,1180].

Percutaneous needle tenotomy has been attempted to treat chronic tendinoses [810,811,812,813,1321]. Glycosaminoglycan injections have been used for treatment of patellar tendinosis. Prolotherapy is performed with various sclerosing agents, including polidocanol and hypertonic saline. These have been used to treat chronic patellar tendinopathy. Aprotinin injections have been utilized for treatment of patellar tendinopathy as an anti-inflammatory treatment [1322].

PLATELET-RICH PLASMA AND AUTOLOGOUS BLOOD INJECTIONS FOR PATELLAR TENDINOPATHY

Not Recommended

Platelet-rich plasma and autologous blood injections are not recommended for the treatment of patellar tendinopathy.

Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

There are no sizable placebo-controlled trials. One small, placebo-controlled trial for patellar tendinopathy suggested a lack of efficacy (Resteghini P, 2016), and another found lack of efficacy for either leukocyte-rich or leukocyte-poor PRP injections (Scott et al., 2019). Trials conflict regarding inferiority v. superiority of PRP over dry needling (Herrero et al., 2024, van der Heijden et al., 2024, Dragoo et al., 2014). Another trial found no differences between 1 and 2 injections (Kaux JF, 2016) while another found 2 injections better than one (Zayni R, 2015). There are two moderate-quality trials suggesting PRP is superior to extracorporeal shockwave therapy, but ESWT appears ineffective (see ESWT) (Smith et al., 2014, Vetrano et al., 2013).

There are many low-quality trials, mostly due to small sample sizes (Resteghini P, 2016, Kaux JF, 2016, Zayni R, 2015, Dragoo et al., 2014, de Almeida et al., 2012). There is no Cochrane

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review of PRP for patellar tendinopathy; however, a more generic Cochrane review of another tendon disorder, lateral epicondylopathy, concluded there was not (Karasavvidis et al., 2021).

PRP injections are invasive, have adverse effects, are costly, and most placebo-controlled trials suggest lack of efficacy; thus, they are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Platelet-rich plasma, autologous blood injections; Tendinopathy, patellar tendinosis, patellar tendinopathy, jumper's knee, patellofemoral pain syndrome, anterior knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 326 articles in PubMed, 141 in CINAHL, 7 in Cochrane Library, 4390 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 8 from Google Scholar, and 0 from other sources. Of the 8 articles considered for inclusion, 3 randomized trials and 0 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

APROTININ INJECTIONS FOR PATELLAR TENDINOPATHY

No Recommendation

There is no recommendation for or against aprotinin injections to treat patellar tendinopathy.

Strength of evidence No Recommendation, Insufficient Evidence (I)
Level of confidence Low

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Indications

Chronic patellar tendinopathy that is unresponsive to other treatments including NSAID(s), exercise, and activity modification.

Rationale

There is one moderate-quality placebo-controlled trial that evaluated the use of paratendon, bursal, and tendinous insertion area aprotinin injections for the treatment of patellar tendinopathy and found suggested some efficacy (Capasso, 1997). However, the trial has not been replicated and the evidence is now quite old, thus, there is no recommendation for or against these injections.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Aprotinin injections; Tendinopathy, patellar tendinosis, patellar tendinopathy, jumper's knee, patellofemoral pain syndrome, anterior knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 2 articles in PubMed, 7 in CINAHL, 0 in Cochrane Library, 312 in Google Scholar, and 0 from other sources†. Zero articles met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

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GLYCOSAMINOGLYCAN INJECTIONS FOR PATELLAR TENDINOSIS

Not Recommended

Glycosaminoglycan injections are not recommended for treatment of patellar tendinosis.

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Strength of evidence Not Recommended, Evidence (C)
Level of confidence Low

Rationale

One moderate-quality trial has suggested a lack of efficacy of glycosaminoglycan injections (Kannus et al., 1992). A small, low quality trial of PRP v. hyaluronic acid injections suggested PRP was better. Thus, these injections are not recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Glycosaminoglycan injection, Hyaluronic Acid injection; Tendinopathy, patellar tendinosis, patellar tendinopathy, jumper's knee, patellofemoral pain syndrome, anterior knee pain; controlled clinical trial, controlled trials, randomized controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 70 articles in PubMed, 13 in CINAHL, 0 in Cochrane Library, 7947 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 2 from Google Scholar, and 0 from other sources. Of the 2 articles considered for inclusion, 1 randomized trial and 1 systematic review met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

SURGICAL CONSIDERATIONS

Several surgical procedures have been performed for anterior knee pain and patellofemoral pain syndrome. These have included lateral retinacular release or lengthening and arthroscopic lateral retinacular release for recurrent subluxation, and surgical realignment of the extensor mechanism has been used for some patients [1323-1334]. Lateral release has

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been performed without [748,1335-1340], as well as in conjunction with, medial soft-tissue realignment for recurrent patellar instability [1341-1347]. Although there are no RCTs, a comparison of these procedures concluded that medial soft-tissue realignment is superior [1344].

SURGERY FOR ANTERIOR KNEE PAIN

Sometimes Recommended

Surgery is recommended for select patients with anterior knee pain after a 6-month period of failed nonoperative treatment, provided the patient also has one or more of the below indications.

Strength of evidence Recommended, Insufficient Evidence (I)
Level of confidence Low

Indications

Moderate to severe anterior knee pain of at least 6 months duration with failed non-operative treatment (including 2 to 3 months of supervised exercises and home-exercise program components with which the patient has been compliant) and one or more of the following: 1) clinical and radiographical evidence of patellar malalignment; 2) clinically and/or radiographically proven subluxation; and/or 3) repeated episodes of patellar dislocation.

Rationale

One trial has suggested arthroscopic surgery for patellofemoral syndrome was of no additive benefit to a home exercise program, although it included techniques that are no longer recommended such as chondroplasty (Kettunen et al., 2007). Other trials have compared operative techniques (Fernandez-Fairen et al., 2010), including one suggesting no differences between open and arthroscopic lateral release (O'Neill, 1997). Thus, there is one trial comparing operative with nonoperative management (Camanho et al., 2009), but no trials available that include optimal techniques. A Cochrane review found the evidence was of low quality and did not conclude whether surgery was beneficial over eccentric exercises and injections (Dan et al., 2019). Patients who have failed nonoperative management are very difficult to treat, and surgery should be carefully weighed against potential failure to improve. For select patients who have significant functional impairment due to patellar malalignment, subluxation, or recurrent dislocation and have failed exercises and nonoperative management with which they have been compliant, an attempt at surgical intervention is selectively recommended.

Evidence

A comprehensive literature search was conducted using PubMed, Scopus, CINAHL, Cochrane Library, and Google Scholar without date limits using the following terms: Surgery; Tendinopathy, patellar tendinosis, patellar tendinopathy, jumper's knee, patellofemoral pain syndrome, anterior knee pain; controlled clinical trial, controlled trials, randomized

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controlled trial, randomized controlled trials, random allocation, random*, randomized, randomization, randomly; systematic, systematic review, retrospective, and prospective studies. We found and reviewed 1925 articles in PubMed, 354 in CINAHL, 0 in Cochrane Library, 3230 in Google Scholar, and 0 from other sources†. We considered for inclusion 0 from PubMed, 0 from CINAHL, 0 from Cochrane Library, 1 from Google Scholar, and 0 from other sources. Of the 1 articles considered for inclusion, 0 randomized trials and 1 systematic reviews met the inclusion criteria.

Literature searches were conducted to update prior comprehensive literature searches performed for the Knee Disorders guidelines editions published in 2011 and 2019. Those prior systematic searches also used multiple databases (PubMed, CINAHL, Cochrane, and Google Scholar). Thus, although the current update searched the literature from 2015 to the present, these searches were combined with the systematic review evidence from prior guideline versions. Because earlier versions did not restrict publication dates, the full evidence base used in this guideline includes all relevant studies identified without date constraints.

† The results for databases are sorted by relevancy based on customized search term algorithms. Algorithms for each database determine relevancy. The first 100 articles are reviewed in each search, and if relevant literature appears in the first 100 articles, we review an additional 100 articles. If relevant articles appear in these additional 100 articles, we then review another 100. We continue this pattern of review until we review a batch of 100 articles that contains no relevant literature. When this happens then the remaining articles are not reviewed due to a lack of relevancy.

APPENDIX 1: PICOT QUESTIONS

Interpretation Guide

- P (Population): the target group or setting (e.g., working-aged adults).
- I (Intervention): therapy, diagnostic test, or preventive measure being assessed.
- C (Comparison): the alternative (standard care or placebo).
- O (Outcome): expected effect (pain relief, function, adverse events).
- T (Time): duration or follow-up when applicable.

Knee Pain – Diagnostic Recommendations

1. Are antibodies recommended to diagnose knee pain with suspicion of a rheumatological disorder?
P: Working-aged individuals with knee pain
I: Antibody testing (rheumatologic panel)
C: No antibody testing or alternate diagnostic methods
O: Accurate diagnosis of rheumatologic conditions
T: N/A

2. Are non-specific inflammatory markers recommended to screen for inflammatory disorders in subacute or chronic knee pain patients?
P Working-aged individuals with subacute or chronic knee pain

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I Measurement of ESR, CRP or other markers
C No screening or specific markers only
O Identification of inflammatory etiology
T N/A

3. Is bone scanning recommended for select use in acute, subacute, or chronic knee pain?
P Patients with acute, subacute, or chronic pain
I Bone scintigraphy (bone scan)
C MRI, CT, or no imaging
O Detection of occult bony pathology
T N/A

4. Are X-rays recommended to evaluate acute, subacute, or chronic knee pain?
P Patients with acute, subacute, or chronic pain
I Plain radiography (X-ray)
C MRI or CT or no imaging
O Detection of fracture or degenerative findings
T N/A

5. Are CTs recommended to evaluate patients with acute, subacute, or chronic knee pain?
P Patients with knee pain (any duration)
I Computed tomography (CT)
C Plain radiography or MRI only
O Enhanced bony detail and diagnostic clarity
T N/A

6. Is MRI recommended for knee joint pathology (meniscal or ligament tears, muscle injury, or post-arthroplasty pain)?
P Patients with suspected internal derangement or post-arthroplasty pain
I MRI of knee joint
C Physical exam or X-rays only
O Accurate soft-tissue diagnosis
T N/A

7. Are MR arthrograms recommended for advanced meniscal and cartilage imaging or post-chondrocyte implantation evaluation?
P Patients requiring specialized cartilage assessment
I MR arthrogram
C Standard MRI
O Improved definition of cartilage and meniscal tears
T N/A

8. Is ultrasound recommended for evaluating patellar tendinopathy, ACL, bursitis, or peri-articular masses?
P Patients with soft-tissue pathology or peri-articular mass
I Musculoskeletal ultrasound (US)
C MRI or clinical exam alone
O Accurate localization and diagnosis of soft tissue abnormalities
T N/A

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9. Is electromyography recommended to diagnose subacute or chronic peripheral nerve entrapments?
P Patients with suspected nerve entrapment causing knee pain
I Electromyography and nerve-conduction tests
C Clinical assessment alone
O Identification of neuropathy type and location
T N/A

10. Are local anesthetic injections recommended to diagnose subacute or chronic knee pain?

P Patients with unclear pain origin
I Diagnostic local anesthetic injection
C No injection or imaging diagnosis only
O Localization of pain source
T N/A

11. Is knee arthroscopy recommended to diagnose and treat mechanical pain or meniscal tears?
P Patients with suspected intra-articular mechanical pathology
I Diagnostic and therapeutic arthroscopy
C MRI alone
O Accurate diagnosis and symptom relief
T N/A

12. Are saline load tests recommended for select knee lacerations?
P Patients with peri-articular laceration and potential joint involvement
I Saline load test
C Clinical exam or radiologic test alone
O Detection of capsular violation
T N/A

Knee Pain and Osteoarthrosis – Activity Modification and Exercise

13. Is activity modification recommended for acute, subacute, or chronic knee pain?
P Working-age adults with knee pain
I Activity modification and exercise plan
C No activity change
O Improved function and pain reduction
T N/A

14. Is bed rest and non-weight bearing recommended for unstable fractures?
P Patients with unstable knee fracture
I Bed rest and non-weight bearing
C Early ambulation or partial weight-bearing
O Safe fracture healing and alignment
T Acute phase

15. Is aerobic exercise recommended for knee osteoarthrosis?
P Patients with knee OA
I Aerobic training (walking, cycling, aqua aerobics)
C No exercise or usual care

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O Improved function and pain scores
T Ongoing

16. Are stretching exercises recommended for knee osteoarthrosis?
P Patients with OA
I Stretching exercises for lower extremity
C No stretching routine
O Increased ROM and decreased pain
T N/A

17. Are strengthening exercises recommended for knee osteoarthrosis?
P Patients with OA
I Quadriceps and hip muscle strengthening
C No strength-training
O Pain reduction and functional mobility gain
T N/A

18. Are educational sessions recommended for knee osteoarthrosis?
P Patients with OA
I Patient education on activity and self-care
C Printed information only or none
O Increased self-management and pain awareness
T N/A

19. Is gait training recommended for knee OA?
P Patients with OA
I Gait training exercises
C No gait training
O Improved biomechanics and pain relief
T N/A

20. Is aquatic therapy (including balneotherapy) recommended for knee OA?
P Patients with OA
I Aquatic exercise and pool therapy
C Land exercise or none
O Pain reduction and functional improvement
T Weeks

21. Is yoga recommended for chronic knee pain?
P Adults with chronic knee pain
I Yoga postures and mind-body practice
C No exercise or conventional exercise
O Pain and functional improvement
T N/A

22. Are ergonomic interventions recommended for prevention of knee MSDs?
P Workers at risk for knee stress injuries
I Ergonomic training and workplace modifications
C No prevention program
O Reduced MSD incidence and pain
T N/A

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Knee Pain and Osteoarthrosis – Medications

23. Is acetaminophen recommended for acute, subacute, chronic, or post-operative pain?
P Patients with knee pain (all stages)
I Acetaminophen (paracetamol) use
C Placebo or no treatment
O Pain relief and improved function
T N/A

24. Are NSAIDs recommended for acute, subacute, chronic, or post-operative pain?
P Patients with knee pain
I NSAID therapy (oral, IV or topical)
C Acetaminophen or placebo
O Pain and inflammation reduction
T Short-term

25. Are topical NSAIDs recommended for knee pain?
P Patients with acute or chronic pain
I Topical NSAID (gel or patch)
C Oral NSAIDs or placebo
O Localized pain relief with fewer side effects
T N/A

26. Is Suzetrigine recommended in acute pain?
P Patients with acute knee pain
I Suzetrigine analgesic medication
C NSAID or placebo
O Effective pain relief and safety
T Short term

27. Are proton pump inhibitors recommended to reduce GI side effects?
P NSAID or ASA users at GI risk
I PPI therapy
C No protection or H2 blocker
O Prevention of ulcer or bleeding
T Concurrent

28. Is Misoprostol recommended with NSAID or ASA use?
P Knee pain patients using NSAID/ASA
I Misoprostol co-therapy
C No protective agent
O Reduced GI adverse events
T Concurrent

29. Is Sucralfate recommended for patients at risk for GI effects?
P At-risk NSAID/ASA users
I Sucralfate protection
C PPI or none
O Lower mucosal damage risk
T Concurrent

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30. Are H_2 blockers recommended for GI protection with NSAIDs?
P Patients on NSAIDs/ASA
I H_2 blocker (famotidine etc.)
C PPI or none
O Reduced ulcer risk
T Therapy course

31. Is routine opioid use recommended for non-severe acute pain?
P Patients with mild acute pain
I Opioid analgesic
C NSAID or acetaminophen
O Pain control and risk balance
T Short term

32. Are opioids recommended for acute, severe pain?
P Post-injury or surgical patients with severe pain
I Opioid therapy
C Non-opioid analgesic
O Pain relief and function
T Acute phase

33. Is screening recommended prior to initiating opioids?
P Patients needing opioid trial
I Risk assessment and screening
C None
O Reduced misuse risk
T Before therapy

34. Are opioid dose limits recommended in acute pain?
P Acute-pain patients on opioids
I Dose limiting
C No limit
O Safer use and fewer adverse effects
T Short term

35. Is limited opioid use recommended for post-operative pain?
P Post-operative patients
I Short-duration opioids
C Long-term course
O Pain relief and reduced dependence
T Immediate post-op

36. Are dose limits recommended in post-operative pain?
P Surgical patients on opioids
I Set dose limit / taper
C Unlimited dose
O Reduced risk and side effects
T Short term

37. Is screening advised before continuing opioids post-op?
P Post-surgical patients

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I Behavioral and risk screening
C None
O Avoid chronic opioid dependence
T At follow-up

38. Is routine opioid use recommended for subacute and chronic non-malignant pain?
P Chronic pain patients without cancer
I Long-term opioid therapy
C Non-opioid treatments
O Pain control and function outcomes
T Long term

39. Are opioids recommended for severe subacute or chronic pain?
P Chronic pain patients with severe symptoms
I Opioid use
C Non-opioid modalities
O Pain reduction and function improvement
T Medium term

40. Is screening recommended for subacute patients before opioids?
P Subacute pain patients eligible for opioids
I Risk assessment
C No screening
O Reduce misuse and adverse events
T Before therapy

41. Are opioid treatment agreements recommended?
P Patients receiving opioids for knee pain
I Treatment contract for safe opioid use
C No agreement
O Better compliance and monitoring
T During course

42. Are dose limits recommended in subacute/chronic pain?
P Patients on prolonged opioid therapy
I Dose caps or max thresholds
C Unlimited dosing
O Reduced risk of dependence
T Throughout treatment

43. Is urine drug screening recommended?
P Chronic opioid patients
I Periodic urine toxicology screen
C No screen
O Detection of misuse
T Ongoing

44. Are skeletal muscle relaxants recommended in knee pain?
P Patients with pain and muscle spasm
I Muscle relaxant medication
C NSAID or none

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O Pain reduction and ease of movement
T Short term

45. Do antidepressants (e.g., Duloxetine) improve knee pain?
P Patients with acute or chronic pain
I Duloxetine or other SNRIs
C Placebo or NSAID
O Pain relief and function improvement
T Weeks

46. Is Topiramate recommended for OA or knee pain?
P OA patients or chronic pain
I Topiramate
C Placebo
O Pain control and tolerance
T N/A

47. Is Gabapentin recommended for OA or chronic knee pain?
P OA or neuropathic-type pain patients
I Gabapentin
C Placebo or standard care
O Pain and sleep improvement
T Weeks

48. Is Gabapentin recommended for peri-operative pain?
P Surgical patients (knee procedure)
I Peri-operative Gabapentin
C Placebo or analgesic protocol
O Reduced post-op pain and opioid use
T Immediate peri-op

49. Is Glucosamine/Chondroitin/MSM recommended for OA?
P OA patients
I Glucosamine sulfate, chondroitin sulfate, or MSM
C Placebo or none
O Joint pain and function improvement
T Months

50. Is Diacerein recommended for OA?
P OA patients
I Diacerein
C NSAID or placebo
O Pain relief and structure modification
T N/A

51. Has Vitamin D shown efficacy in OA?
P OA patients
I Vitamin D supplementation
C Placebo
O Pain reduction and cartilage preservation
T Months

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52. Is TrkA inhibition recommended for OA pain?
P Patients with knee OA
I TrkA inhibitor medication
C Placebo or NSAID
O Pain relief and function gain
T N/A

53. Is hydrolyzed or non-hydrolyzed collagen effective in OA?
P OA patients
I Collagen supplement (hydrolyzed or not)
C Placebo
O Reduced pain and functional improvement
T Months

54. Are complementary/alternative treatments recommended for knee pain?
P Patients with acute, subacute, or chronic pain
I Dietary supplements and herbal remedies
C Standard medical care
O Pain reduction and functional benefit
T N/A

Knee Pain and Osteoarthrosis – Devices

55. Are off-loader braces recommended for OA?
P Medial/lateral compartment OA patients
I Off-loading brace
C Elastic sleeve or no brace
O Pain relief and function gain
T N/A

56. Are knee pads recommended for kneeling tasks?
P Workers performing kneeling duties
I Protective knee pads
C No protection
O Prevention of bursitis and pain
T During task

57. Are neoprene sleeves recommended for OA?
P OA patients
I Neoprene support sleeve
C No sleeve
O Pain relief and improved stability
T N/A

58. Are lateral wedges and orthotics recommended for OA?
P Medial compartment OA
I Lateral wedge insole or custom orthotic
C Flat insole or none
O Decreased pain and varus load
T N/A

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59. Are braces or splints recommended post-knee surgery?
P Post-operative patients
I Knee brace or splint
C No brace or early mobilization
O Joint stability and recovery
T Immediate post-op

60. Are motorized scooters recommended for severe chronic OA?
P Patients with severe OA and limited mobility
I Motorized scooter use
C Walker, cane, or no device
O Improved independence and quality of life
T Chronic phase

61. Are canes and crutches recommended for moderate-to-severe acute, subacute, or chron ic knee pain?
P: Patients with moderate-to-severe knee pain
I: Use of canes or crutches
C: No assistive device
O: Improved stability and pain relief during walking
T: Temporary or long-term, as needed

62. Are magnets and magnetic stimulation recommended for osteoarthrosis or knee pain?
P Patients with OA or chronic pain
I Static or pulsed magnetic field therapy
C Placebo device or no treatment
O Pain reduction and improved joint function
T N/A

Knee Pain and Osteoarthrosis – Hot and Cold Therapies

63. Is home cryotherapy recommended for knee OA or pain?
P OA or post-injury patients
I Home-use ice packs, cold compresses
C No cryotherapy
O Less swelling and pain
T As needed

64. Is cryotherapy, including ice machines, recommended for knee arthroplasty or arthrosco py patients?
P Post-op patients after TKA or arthroscopy
I Continuous cold-therapy devices
C Standard care without cryotherapy
O Pain relief and decreased swelling
T Immediately post-op

65. Is self-applied heat therapy recommended for knee pain or OA?
P OA or chronic pain patients
I Heat packs or heating pads
C No heat or cold treatment

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O Pain control and muscle relaxation
T Short term

66. Is therapeutic ultrasound recommended for knee pain?
P Patients with acute or chronic knee pain
I Therapeutic ultrasound sessions
C Sham ultrasound or none
O Pain reduction and improved mobility
T Short term

67. Is phonophoresis recommended for knee pain?
P Patients with OA or painful joint
I Phonophoresis (drug delivery via ultrasound)
C Topical drug alone or sham therapy
O Enhanced drug absorption and pain relief
T Short term

Knee Pain and Osteoarthrosis – Allied Health Interventions

68. Is massage therapy recommended for knee OA or pain?
P Patients with OA or chronic knee pain
I Massage therapy
C No massage or usual care
O Pain relief and increased flexibility
T N/A

69. Is reflexology recommended for OA or knee pain?
P Patients with OA or chronic pain
I Reflexology sessions
C Sham therapy or none
O Pain reduction and well-being
T Short term

70. Is acupuncture, acupressure, acupotomy, moxibustion, or dry needling recommended fo r knee pain?
P Adults with acute, subacute, or chronic knee pain
I Acupuncture-based therapy
C Sham procedure or standard care
O Pain relief and functional improvement
T N/A

71. Is manipulation or mobilization recommended for knee pain, knee OA, or post-fracture p atients?
P Patients with restricted knee motion
I Manual therapy (manipulation/mobilization)
C Exercise only (no manual therapy)
O Improved range of motion and pain relief
T Rehab period

72. Is manipulation or mobilization recommended post-op for reduced ROM?
P Post-op patients with stiffness
I Manual mobilization after surgery

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C Physical therapy without manual mobilization
O Improved ROM and joint function
T Early post-op

73. Is manipulation under anesthesia (MUA) recommended for stiff post-op knee?
P Patients with post-TKA stiffness
I MUA procedure
C Physical therapy alone
O Improved motion and pain relief
T Weeks to months post-TKA

74. Is shockwave therapy (ESWT) recommended for knee OA?
P Patients with knee OA
I Extracorporeal shockwave therapy
C Sham therapy or routine care
O Pain relief and mobility improvement
T Weeks to months

75. Is laser therapy recommended for OA or knee pain?
P Patients with OA or chronic pain
I Low-level laser therapy (LLLT)
C Sham laser or none
O Pain relief and functional gain
T Short term

76. Is radiation synovectomy recommended for OA?
P Patients with inflammatory OA synovitis
I Radiation synovectomy procedure
C Conservative care or surgical synovectomy
O Reduced pain and swelling
T Medium term

Knee Pain and Osteoarthrosis – Electrical Therapies

77. Is pulsed electromagnetic field (PEMF) therapy recommended for OA or pain?
P Patients with OA or knee pain
I PEMF device treatment
C Sham device or no therapy
O Pain and function improvement
T N/A

78. Is neuromuscular electrical stimulation (NMES) recommended for OA or post-op knee pa
in?
P Patients with OA or muscle atrophy
I NMES therapy
C Exercise alone
O Improved strength and pain relief
T Weeks

79. Is iontophoresis recommended for OA or pain?
P Patients with OA or inflammatory pain
I Iontophoresis (drug delivery with electrical current)

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C Topical drug application only
O Increased drug penetration and pain relief
T Short term

80. Is interferential therapy recommended for post-op knee patients?
P Knee surgery patients
I Interferential electrical stimulation
C Physical therapy alone
O Pain relief and enhanced healing
T Immediately post-op

81. Is microcurrent therapy recommended for total knee arthroplasty (TKA) patients?
P Post-TKA patients
I Microcurrent electrical therapy
C Standard rehab without microcurrent
O Pain decrease and improved wound healing
T Post-op period

82. Is percutaneous electric nerve stimulation (PENS) recommended for OA or knee pain?
P Patients with OA or chronic pain
I PENS therapy
C TENS or no therapy
O Pain reduction and function gain
T Treatment series

83. Is transcutaneous electrical nerve stimulation (TENS) recommended for knee pain?
P Patients with acute or chronic pain
I TENS therapy
C Placebo device or no treatment
O Pain relief and mobility improvement
T Short term

84. Is transcranial direct current stimulation (tDCS) recommended for knee pain or OA?
P Patients with chronic pain or OA
I tDCS neuromodulation
C Sham stimulation or no therapy
O Reduced pain central perception
T Short term

Knee Pain and Osteoarthrosis – Injection Therapies

85. Are PRP or growth factor injections recommended for moderate-to-severe OA?
P Patients with OA
I Platelet-rich plasma (PRP) or growth factor injection
C Hyaluronic acid or saline injection
O Pain relief and function gain
T Months

86. Are TNF-alpha blockers recommended for OA or chronic non-inflammatory knee pain?
P OA patients without inflammatory arthritis
I TNF-alpha inhibitor therapy
C NSAID or placebo

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O Pain and inflammation control
T N/A

87.Is sprifermin (FGF18) recommended for OA?
P Patients with OA
I Sprifermin (FGF18) injection
C Placebo
O Cartilage growth and pain reduction
T Months to years

88. Are TPX-100 peptide injections recommended for OA?
P Patients with OA
I TPX-100 peptide injection
C Placebo or standard care
O Cartilage repair and symptom relief
T N/A

89. Is genicular artery embolization recommended for OA?
P Patients with painful OA
I Genicular artery embolization procedure
C Conservative care or injection therapy
O Pain and inflammation reduction
T Months

90. Is lorecivivint recommended for OA?
P OA patients
I Lorecivivint injection (Wnt modulator)
C Placebo
O Cartilage preservation and pain relief
T N/A

91. Are autologous blood injections recommended for moderate-to-severe OA?
P OA patients
I Autologous blood injection
C Placebo or PRP
O Pain improvement and tissue regeneration
T Months

92. Is viscosupplementation recommended for OA or meniscal pain?
P OA or meniscal-pathology patients
I Hyaluronic acid injection
C Saline placebo or steroid injection
O Pain relief and function improvement
T Weeks to months

93. Is stem cell therapy effective for OA?
P Patients with moderate to severe OA
I Stem cell joint injection
C Placebo or PRP
O Cartilage regeneration and pain relief
T Months to years

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94. Are intra-articular steroids recommended for OA?
P Patients with OA flares
I Corticosteroid injection
C Saline placebo or HA injection
O Pain reduction and function gain
T Weeks

95. Is combination Tr14 + Ze14 (Traumeel and Zeel) injection recommended for OA?
P OA patients
I Tr14 + Ze14 homeopathic combination intra-articular injection
C Placebo or saline
O Pain and mobility improvement
T Weeks to months

96. Is tidal joint irrigation recommended for OA?
P Chronic OA patients
I Arthroscopic joint lavage procedure
C Conservative treatment
O Short-term pain relief
T Immediate

97. Are prolotherapy injections recommended for knee pain?
P Patients with knee pain of any duration
I Prolotherapy (dextrose injection)
C Saline or PRP therapy
O Long-term pain and stability improvement
T Months

98. Are botulinum toxin injections recommended for OA or knee pain?
P Patients with knee OA or chronic pain
I Intra-articular botulinum toxin type A
C Saline placebo or corticosteroid
O Pain relief and function gain
T 3 months

99. Are interleukin-1 receptor antagonists recommended for OA?
P Patients with OA symptoms
I IL-1 receptor antagonist (e.g., Anakinra)
C Placebo or steroid injection
O Pain and inflammation reduction
T Weeks

100. Is radiofrequency ablation (RFA) recommended for OA?
P Patients with chronic painful OA
I Genicular nerve RFA
C Conservative therapy or placebo
O Pain relief and function improvement
T Months

Knee Pain and Osteoarthrosis – Surgical Considerations

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101. Is chondroplasty and debridement recommended for OA?
P OA patients with loose cartilage fragments
I Arthroscopic chondroplasty and debridement
C Conservative management
O Symptom relief and improved function
T Months to years

102. Is knee joint distraction effective for OA?
P Advanced OA patients
I Joint distraction using external fixation
C Conventional care or TKA
O Cartilage repair and pain reduction
T Long term

103. Are cartilage grafts or osteochondral transplants recommended for cartilage defects?
P Patients with focal cartilage lesions
I OATS or ACI procedures
C Microfracture technique or non-surgical care
O Pain reduction and better joint function
T Months to years

104. Is knee arthroplasty recommended for moderate-to-severe arthritis?
P Patients with advanced arthritis
I Total knee arthroplasty (TKA)
C Continued non-surgical care
O Long-term pain and function improvement
T Years

105. Is unicompartmental arthroplasty recommended for unicompartmental OA?
P Patients with OA limited to one compartment
I Unicompartmental knee arthroplasty (UKA)
C Total knee arthroplasty or non-operative management
O Pain relief and improved function
T Long-term

Rehabilitation Programs

106. Are pre-operative educational programs recommended before arthroplasty?
P Patients scheduled for knee replacement
I Pre-op education on procedure and expectations
C No education
O Reduced anxiety, improved outcomes
T Pre-surgery

107. Are pre-operative exercise programs recommended before arthroplasty?
P Patients awaiting TKA
I Structured exercise (prehabilitation)
C No exercise before surgery
O Improved post-op recovery and function
T Pre-op phase

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108. Is post-operative rehab recommended after arthroplasty?
P TKA patients
I Structured rehabilitation program (PT and exercise)
C Home exercise only or minimal care
O Better functional outcome and mobility
T 0–3 months post-op

109. Is continuous passive motion (CPM) recommended for arthroplasty patients?
P Patients after TKA
I Continuous passive motion device
C Standard PT alone
O Early ROM improvement
T Immediate post-op

110. Are post-operative vocational activities recommended after arthroplasty?
P Post-arthroplasty patients returning to work or hobby
I Graduated return to activity protocol
C Unsupervised return
O Safe work reintegration and performance
T Weeks to months

111. Are work conditioning programs recommended for chronic knee pain?
P Workers with chronic knee pain
I Work conditioning programs
C Standard care alone
O Improved work tolerance and pain management
T Months

112. Are interdisciplinary pain rehab programs recommended for chronic knee pain?
P Patients with refractory chronic pain
I Multimodal pain rehabilitation (PT + psych + MD)
C Standard care alone
O Improved function and coping skills
T Months

113. Are compression devices (e.g., stockings, pumps) recommended to prevent VTE?
P Post-surgery patients at DVT risk
I Compression devices or stockings
C No mechanical prophylaxis
O Reduced VTE risk
T Immediate post-op

114. Is low-molecular-weight heparin recommended for VTE prevention?
P Surgical patients at risk of VTE
I LMWH drug prophylaxis
C Placebo or no anticoagulant
O Reduced VTE events
T Post-op

115. Are Factor Xa inhibitors recommended for VTE prophylaxis?
P Post-arthroplasty patients

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I Factor Xa inhibitor (rivaroxaban/apixaban)
C LMWH or warfarin
O Reduced VTE risk with manageable bleeding
T Post-op

116. Is there efficacy in Factor XIa inhibitors for preventing DVTs?
P Post-op patients requiring anticoagulation
I Factor XIa inhibitor
C LMWH or Xa inhibitor
O Similar efficacy with lower bleeding events
T Short term

117. Are warfarin and heparin or anti-fibrinolytics recommended for VTE prevention?
P Post-surgical patients
I Warfarin or heparin
C LMWH or Xa inhibitor
O Reduced VTE risk
T Post-op

118. Is aspirin recommended to prevent VTE disease?
P Post-arthroplasty or fracture patients
I Low-dose aspirin prophylaxis
C No thromboprophylaxis or LMWH
O Reduced VTE with low bleeding risk
T Short to medium term

Behavioral and Psychological Interventions

119. Is psychological evaluation recommended for chronic knee pain?
P Patients with chronic knee pain and functional limitations
I Psychologic evaluation or consultation
C No evaluation
O Improved treatment compliance and coping skills
T Ongoing

120.Is Cognitive behavioral therapy (CBT) recommended for subacute or chronic knee pain?
P Patients with persistent pain
I CBT sessions targeting pain coping
C Standard PT only
O Improved self-management and function
T Weeks to months

Iliotibial Band Syndrome – Treatment Recommendations

121.Is kinesiotaping recommended for treating iliotibial band syndrome?
P: Patients with iliotibial band syndrome (ITBS)
I: Kinesiotaping of the IT band and surrounding muscles
C: No taping or standard therapy

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O: Pain reduction and functional improvement
T: Short term

122. Is stretching recommended in the treatment of iliotibial band syndrome?
P Patients with ITBS
I Targeted stretching of the IT band and related muscles
C No stretching or rest only
O Pain relief and improved flexibility
T Short term

123. Is strength training recommended for iliotibial band syndrome?
P Patients with ITBS
I Hip and leg strengthening programs
C Stretching only or conventional care
O Reduced pain and recurrence
T Weeks to months

124. Is manual therapy or mobilization effective for iliotibial band syndrome?
P Patients with ITBS
I Manual therapy and joint mobilization
C Exercise alone or standard therapy
O Pain relief and soft-tissue mobility increase
T Short term

125. Is transverse friction massage recommended for iliotibial band syndrome?
P Patients with ITBS
I Transverse friction massage
C Standard care or rest only
O Pain reduction and tissue healing
T Short term

126. Is shockwave therapy (ESWT) recommended for ITBS?
P Patients with ITBS
I Extracorporeal shockwave therapy
C Placebo or conservative management
O Pain and function improvement
T Weeks

127. Are glucocorticosteroid injections recommended for iliotibial band syndrome?
P Patients with persistent ITBS pain
I Corticosteroid injection
C Physical therapy alone
O Rapid pain relief and functional gain
T Short term

128. Is platelet-rich plasma (PRP) or growth factor injection recommended for iliotibial band syndrome?
P Patients with refractory ITBS
I PRP or growth factor injection
C Steroid or placebo injection

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O Improved pain and tissue healing
T Months

129. Is surgery recommended for iliotibial band syndrome?
P Patients with chronic ITBS unresponsive to conservative care
I Surgical IT band release/resection
C Non-surgical management
O Pain relief and return to function
T Post-surgical months

Quadriceps, Gastrocnemius, Hamstring, Hip Flexor and Soleus Strains

130. Are work limitations recommended for muscle strains?
P Workers with lower extremity strain
I Work modification and restricted duty
C Regular work
O Reduced re-injury risk and improved recovery
T Acute period

131. Is PATS (Physical Agent Therapy Strategies) recommended for muscle strains?
P Patients with muscle strains
I Heat, ultrasound, or electrical agents therapy
C Rest or exercise alone
O Pain reduction and healing promotion
T Short term

132. Is kinesiotaping recommended in treating knee strains?
P Patients with knee muscle strain
I Kinesiotaping across injured muscle
C No taping or standard care
O Pain reduction and support for healing
T Short term

133. Is rehabilitation therapy superior for hamstring or hip flexor strain?
P Patients with hamstring or hip flexor strain
I Structured rehabilitation program
C Rest and self-care alone
O Quicker return to activity
T Weeks

134. Is surgery superior to other interventions for severe muscle strains or tears?
P Patients with severe muscle tear
I Surgical repair
C Conservative therapy
O Improved function and strength recovery
T Months

Knee Sprains (including Medial and Lateral Collateral Ligaments)

135. Are work limitations recommended for knee sprains?
P Workers with ligament sprains
I Temporary restricted work or activity

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C Full duty
O Reduced pain and facilitated healing
T Short term

136. Is PRP or growth factor injection recommended for knee sprains?
P Patients with sprains
I PRP or growth factor injection
C Conventional rehab or placebo
O Accelerated healing and pain reduction
T Weeks

137. Is surgery recommended for knee sprains?
P Severe ligament sprain with instability
I Surgical repair
C Non-surgical care
O Restored stability and function
T Months

Anterior and Posterior Cruciate Ligament Tears

138. Is post-op knee bracing recommended after ACL reconstruction?
P ACL reconstruction patients
I Functional post-op brace
C No brace
O Injury protection and support during rehab
T Early recovery

139. Is bracing recommended for non-operative ACL injuries?
P ACL tear patients without surgery
I Functional brace
C No brace
O Stability and confidence in movement
T Rehab period

140. Is perturbation training recommended for ACL injury rehab?
P ACL-injured patients in rehabilitation
I Perturbation training (balance and neuromuscular)
C Standard rehab without perturbation
O Improved stability and control
T Weeks to months

141. Is rehabilitation with or without ACL reconstruction recommended?
P Patients with ACL tear
I Structured rehab program (with or without surgery)
C No rehab plan
O Enhanced function and return to activity
T Months

142. Are work limitations recommended for ACL tears?
P Workers with ACL tear
I Restricted duty
C Full duty

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O Protection of healing tissue
T Throughout rehab

143. Is viscosupplementation recommended for ACL tears?
P Patients post-ACL injury or repair
I Hyaluronic acid injection
C Placebo or standard care
O Pain relief and joint motion improvement
T Weeks

144. Is bone marrow concentrate recommended for ACL tears?
P Patients with ACL deficiency
I BMC injection or augmentation
C PRP or standard repair
O Enhanced tissue healing
T Months

145. Is PRP or growth factor injection recommended for ACL tears?
P Patients with ACL injury or surgery
I PRP or growth factor therapy
C No biologic therapy
O Improved healing and function
T Weeks

146. Is surgery recommended for ACL tears?
P Patients with complete ACL rupture
I ACL reconstruction surgery
C Rehabilitation alone
O Restoration of stability and function
T Months to years

Meniscal Tears

147. Are work limitations recommended for meniscal tears?
P Workers with meniscal tear
I Modified activity or restriction
C Full duty
O Pain control and safe recovery
T Acute to subacute

148. Is exercise therapy recommended for meniscal tears?
P Patients with non-surgical meniscal tears
I Therapeutic exercise program
C Rest or surgery
O Improved function and pain reduction
T Weeks to months

149. Are glucocorticosteroid injections recommended for meniscal tears?
P Patients with symptomatic meniscal tear
I Intra-articular steroid injection
C Saline or placebo

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O Short-term pain relief
T Weeks

150. Is rehabilitation recommended after meniscal repair surgery?
P Post-meniscal repair patients
I Structured rehab program
C Minimal care
O Better ROM and functional outcome
T Weeks to months

151. NEW Is injection therapy recommended for meniscal tears?
P Patients with meniscal tear (degenerative or traumatic)
I Intra-articular biologic injection (PRP or other)
C No injection or rehab only
O Pain and function improvement
T Months

152. Are PRP or autologous blood injections recommended for meniscal tears?
P Patients with meniscal injury
I PRP or autologous blood injection
C Conservative management or placebo
O Enhanced healing and functional gain
T Weeks to months

153. Have allografts shown efficacy in meniscal tears?
P Patients with irreparable meniscal defect
I Meniscal allograft transplantation
C Conventional care or meniscectomy
O Pain and function improvement
T Long term

154. Is surgery recommended for meniscal tears?
P Patients with symptomatic tear
I Meniscal repair or arthroscopic partial meniscectomy
C Nonsurgical care
O Functional and pain improvement
T Months

Knee Bursitis

155. Is activity modification to avoid kneeling recommended for bursitis?
P Patients with bursitis
I Avoidance of kneeling and prolonged pressure
C Unmodified activity
O Pain reduction and inflammation control
T Acute phase

156. Is aspiration recommended for infected bursa?
P Patients with infected bursal swelling
I Needle aspiration and drainage
C Antibiotic therapy only

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O Infection control and pain relief
T Immediate

157. Are glucocorticosteroid injections recommended for knee bursitis?
P Patients with non-infected bursitis
I Corticosteroid injection into bursa
C Aspiration or NSAIDs only
O Pain reduction and recurrence prevention
T Short term

158. Is surgery recommended for knee bursitis?
P Chronic or refractory bursitis patients
I Bursectomy or surgical drainage
C Conservative management
O Permanent symptom resolution
T Months

Patellar Tendinosis / Tendinopathy / Anterior Knee Pain

159. Are work limitations recommended for patellofemoral joint pain?
P Workers with patellofemoral pain
I Modified work duty
C Full duty
O Pain reduction and healing protection
T Recovery interval

160. Is exercise recommended for patellofemoral pain?
P Patients with PFJ pain
I Therapeutic exercise (quadriceps and hip strengthening)
C Rest or no therapy
O Pain and function improvement
T Weeks to months

161. Is taping or kinesiotaping recommended for anterior knee pain?
P Patients with anterior knee pain or patellar tendinopathy
I Taping or kinesiotaping methods
C No taping or exercise only
O Short-term pain relief and alignment improvement
T Short term

162. Are orthotics, braces, splints, or wraps recommended for patellofemoral pain?
P Patients with patellofemoral pain
I Orthotic or brace use
C No device
O Pain reduction and stability support
T N/A

163. Is mobilization with dry needling or percutaneous needle tenotomy recommended for patellar tendinopathy?
P Patients with chronic patellar tendinopathy
I Manual mobilization plus needling or tenotomy
C Exercise therapy alone

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O Pain and tendon healing improvement
T Weeks to months

164. Is electrical stimulation recommended for anterior knee pain?
P Patients with anterior knee pain
I Electrical stimulation therapy
C Exercise therapy only
O Pain relief and function gain
T Short term

165. Is biofeedback recommended for patellofemoral pain?
P Patients with patellofemoral pain
I Biofeedback training with rehabilitation
C Exercise only
O Improved muscle activation and pain reduction
T N/A

166. Are glucocorticosteroid injections recommended for patellar tendinopathy?
P Patients with chronic tendinopathy
I Local steroid injection
C PRP or exercise therapy
O Short-term pain relief
T Weeks

167. Are PRP or autologous blood injections recommended for chronic patellar tendinopathy?
P Patients with tendinopathy
I PRP or autologous blood injection
C Steroid injection or standard care
O Improved pain and tendon healing
T Months

168. Are aprotinin injections recommended for patellar tendinopathy?
P Patients with chronic tendinopathy
I Aprotinin injection
C Placebo or standard care
O Pain relief and healing enhancement
T Short term

169. Are glycosaminoglycan or hyaluronic acid injections recommended for chronic patellar tendinosis?
P Patients with chronic tendinosis
I HA or GAG injection
C Placebo or PRP
O Improved pain and function
T Weeks to months

170. Is extracorporeal shockwave therapy (ESWT) recommended for patellar tendinosis?
P Patients with chronic patellar tendinosis
I ESWT treatment
C Conventional rehab or placebo

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O Pain reduction and tendon function improvement
T Weeks

171. Is surgery recommended for anterior knee pain?
P Patients with persistent anterior knee pain or tendinopathy
I Surgical intervention (tendon debridement or realignment)
C Non-surgical rehab management
O Long-term pain relief and functional recovery
T Months to years

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TABLE 1. RED FLAGS FOR POTENTIALLY SERIOUS CONDITIONS ASSOCIATED WITH KNEE PAIN

Disorder	Medical History	Physical Examination
Tumor and Neoplasia	Severe localized pain, often deep-seated, unrelenting bony pain History of cancer (at any point in lifetime) Age >50 years Symptom consistent with disease in a specific organ system (e.g., cough, change in bowel habit, epigastric pain, early satiety) Constitutional symptoms, such as recent unexplained weight loss, fatigue Pain that continues at night or at rest	Pallor, reduced blood pressure, diffuse weakness New mass or tenderness, including tenderness over bony landmarks New findings at a distant site relative to the original complaints, including abnormal pulmonary examination (crackles, wheezes, rhonchi, decreased breath sounds)
Infection	Constitutional symptoms, such as recent fever, chills, or unexplained weight loss Recent bacterial infection (e.g., urinary tract infection); IV drug abuse; diabetes mellitus; or immunosuppression (due to corticosteroids, transplant, or HIV) History of recurring infections treated with antibiotics (e.g., repeated urinary tract infections) This also includes potential tendon ruptures reportedly associated with flurogiunolone antibiotics. Foreign travel with potential exposure to infectious agents	Fever, tachycardia, tachypnea, hypotension Elevated white blood cell count (may be decreased in elderly or immunocompromised) Shift in the WBC differential towards immature cells (“left shift”) Abnormal urinalysis Abnormal body part examination (e.g., pulmonary) Tenderness over bony landmarks Joint effusion, tenderness and difficulty moving knee joint (if knee septic arthritis)
Significant or Progressive Neurologic Deficit	Severe spine or extremity pain Progressive numbness or weakness Complaints of new gait difficulty	Significant or progressive dermatomal and/or myotomal (motor) involvement Evidence of cauda equina syndrome, including urinary retention or bowel incontinence Hyper-reflexia, or other evidence of myelopathy
Compartment Syndrome	History of fracture, crush wound or other major trauma Very painful muscular compartment History of peripheral vascular disease	Tense compartment Exquisitely tender Distal neurovascular compromise (e.g., absent or decreased pulses or pale/cold extremity) if severe and/or prolonged
Rheumatologic Disease	Diffuse arthralgias Prior arthropathies, autoimmune diseases	Polyarticular joint effusions (usually with warmth)

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Disorder	Medical History	Physical Examination
	Skin changes, lesions, or ulcers Fatigue, malaise Joint effusion without prior trauma	Crystals on examination of joint fluid aspirate using polarized light microscopy X-ray abnormalities consistent with erosive pathology Elevated sedimentation rate (ESR) or C-reactive protein (CRP) Hematuria, proteinuria Other specific abnormalities, as appropriate (e.g., ANA, RF, anti-DNA, C3, anti-Ro, anti-La, oral ulcers, pulmonary abnormalities, ophthalmological involvement, dermal abnormalities)

*The above list is not meant to be comprehensive but rather reviews many common historical and examination findings.

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TABLE 2. ABILITY OF VARIOUS TECHNIQUES TO IDENTIFY AND DEFINE KNEE PATHOLOGY

Technique	Meniscus Tear	Ligament Sprain	Ligament Tear	Patello-femoral Syndrome	Tendinopathy	Prepatellar Bursitis	Regional Pain
History	+ +	+ +	+ +	+ + + +	+ + +	+ +	+ +
Physical examination	+ + + +	+ + + +	+ + + +	+ +	+ + + +	+ + + +	+ +
Laboratory studies	0	0	0	0	0	0	0
Electromyography/nerve conduction velocity (EMG/NCV) studies	0	0	0	0	0	0	0
Imaging studies							
Radiography†	0	0	0	+	0	0	0
Bone scan†	0	0	0	+	0	0	0
Arthrography†	+ + +	0	+	0	0	0	0
Computed tomography (CT)†	0	0	0	0	0	0	0
Magnetic resonance imaging (MRI)†	+ + + +	+ + +	+ + + +	+ + +	+ + +	+ + +	0

†Risk of complications (e.g., infection, radiation) highest for arthrography, less for radiography and computer tomography (CT), and lowest for bone scan and MRI.

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TABLE 3. DIAGNOSTIC CRITERIA FOR NON-RED-FLAG KNEE DISORDERS

Probable Diagnosis or Injury	Symptoms	Signs	Tests and Results
Knee Osteoarthrosis	Non-radiating knee pain. Morning stiffness or stiffness upon standing or after prolonged sitting. Sleep disturbance sometimes present as a result of pain, but mood disturbance usually not present. Other joints are often affected.	ROM generally reduced, especially knee flexion. May be normal when mild. Alignment my be abnormal.	X-rays usually ordered to help secure diagnosis. Other diagnostic tests only if there is a potential for meaningful intervention
Patellofemoral Joint Syndrome (chondromalacia patella)	Anterior knee pain. Pain with stair climbing, other activities involving knee flexion, or sitting for a prolonged period of time.	Patellar malalignment. Increased Q-angle. Anterior knee tenderness. Crepitus on range of motion. Pain with patellofemoral compression	X-rays often ordered. Sunrise patella view particularly helpful. Other testing usually not necessary.
Patellar Dislocation and Instability	Inability to bear weight. Acute onset associated with forceful event or accident. Congenital or inherited variants tend to be recurrent. Instability if feeling of impending recurrence of subluxation with specific activities.	Unable to bear weight. Joint line tenderness. Patella visibly displaced. Difficulty extending the knee. Pain with patella translation and/or compression.	Knee x-rays usually ordered. Other testing usually not necessary.
Patellar Tendinopathy	Focal patellar tendon pain. Pain increases with use including stair use and jumping.	Focal tenderness over patella. tendon Resisted knee extension may reproduce pain.	X-rays may demonstrate calcification and osteophytes at inferior patellar pole (which also may be non-specific). Ultrasound may show small tears.
Fractures	Fall, motor vehicle accident, or other significant trauma. Severe pain.	Unable to bear weight. Angulation, deformity, point tenderness, and bony crepitus.	X-rays required. Other testing usually not necessary in the acute treatment setting.
Meniscal Tears	Non-radiating knee pain. Typically provoked with specific, predictable activities in specific position(s). May have symptoms of joint effusion, buckling, clicking, catching or locking. Pain may be worse with pivoting and walking or stair-climbing.	Variable findings depending on extent of tear(s). May have joint effusion and modest warmth. Knee pain often worse with ROM and extent of ROM may be restricted. Pain reproduced with knee rotation and flexion. Click and/or crepitus may be present on exam. McMurray's test has reported 60-70% sensitivity and 70-80% specificity, and Apley's test has reported 40-60% sensitivity and 70-80% specificity,	X-rays often ordered. MRI is sometimes ordered, and MR arthrography may be helpful.

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Probable Diagnosis or Injury	Symptoms	Signs	Tests and Results
		thus neither test is particularly accurate [1348].	
Osteonecrosis	Non-radiating bony pain. History of systemic factors (e.g., diabetes mellitus, alcohol). Pain generally increases with weight-bearing.	Reduced ROM and pain with passive ROM usually present. May have pain with weight bearing. May be unable to bear weight if osseous collapse has occurred.	X-rays required. MRI and CT may be ordered for further evaluation of the necrotic region. Bone scans sometimes ordered.
Infrapatellar, Prepatellar, Suprapatellar, and Anserine Bursitis	Anserine bursitis may be painful, but without clear effusion or exertional component. Other types of bursitis frequently not painful, but do have effusion/swelling.	Tender over anserine bursa. Other bursitis often minimally or not tender. ROM usually normal.	X-rays usually not needed. X-rays sometimes ordered if questions of usual settings, including concerns for infection, osteomyelitis, and foreign body. Other testing usually not required.
Collateral Ligament Sprains and Tears (lateral and medial)	Focal knee joint line pain. Medial more prone to be accompanied by meniscal tear. If complete tear, will typically have instability.	May have antalgic gait, especially if moderate to severe sprain. Focal tenderness over collateral ligament and or instability. Usually no effusion.	X-rays usually ordered in acute setting to rule out fracture, particularly for moderate to severe injuries. MRI may be helpful in chronic setting to rule out associated meniscal tear. Other testing usually not required.
Iliotibial Band Syndrome	Non-radiating lateral knee pain.	Lateral knee pain with use, especially running, cycling. Tender over lateral fascia. Modified/Ober test.	X-ray generally not necessary, but may be indicated if concerns of unusual diagnostic concerns, such as accompanying arthrosis.
Cruciate Ligament Sprains, Tears and Ruptures. (anterior, Posterior)	Sudden pain with accident or other traumatic event. May have giving out and immediate swelling after event. May be asymptomatic. Event usually involved exaggerated adduction and external rotation or abduction.	Effusion if acute tear. Joint laxity with complete tears, including positive Lachman, posterior and/or anterior drawer signs.	X-ray usually ordered in acute setting to rule out fractures. MRI may be helpful.
Non-specific Knee Pain	Non-specific. No acute trauma	None	None
Non-specific Effusion	None. No acute trauma.	Effusion. No signs of infection or other abnormality.	X-ray often ordered, but by definition, normal other than effusion. Need evaluation for rheumatological disorder.

Adapted from AMA Guides to Impairment Rating – 6th edition and Sanders S, et al. Evidence-based clinical practice guidelines for interdisciplinary rehabilitation of chronic nonmalignant pain syndrome patients. *Pain Prac*. 2005;5(4):303-15.

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